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The First Spectrum of Hafnium (Hf I)

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The First Spectrum of Hafnium (Hf I)

William F. Meggers and Charlotte E. Moore

The present publication terminates the work on the analysis of Hf I which was started by the late W. F. Meggers in 1928 and left unfinished in 1966. His final line list contains some 4700 lines of which about 67 percent have been classified. Observed g-values are known for 198 levels. The reliability of the Zeeman observations is indicated in tables containing sums of Observed and Landé g-values for selected groups of "even" and "odd" terms.

An attempt has been made to continue Meggers' analysis in LS-coupling as far as possible. This coupling is not rigorous in Hf I, and many intervals are irregular. Consequently, the levels are given also in numerical order with the even and odd levels presented in separate tables.

An ionization limit of $54700 \pm 600 \text{ cm}^{-1}$, giving an ionization potential of $6.78 \pm 0.07 \text{ eV}$ has been derived from a two-member series.

The long line lists are given in two Appendices: Appendix A contains the observed Zeeman data for the individual lines, 531 in all; Appendix B consists of the complete line list of observed and classified lines.

By far the greater part of the analysis is that of Meggers. Detailed notes explain changes that have been introduced and additions to his work.

Key words: Spectrum, Hf I; Analysis, Hf I Spectrum; Hafnium, Analysis of first spectrum; Zeeman effect, Hf I.

1. Introduction

The first description of the Hf I and Hf II spectra was reported by W. F. Meggers in 1928[1].¹ This paper contains a history of the element hafnium, wavelength measurements of some 1500 lines in the arc and spark spectra of hafnium between 2155 Å and 9250 Å, and a list of 12 persistent lines in each spectrum.

He and B. F. Scribner discovered the first regularities in Hf I in 1930[2]. This was achieved with the aid of the temperature classification of the lines obtained by A. S. King[3] from a study of the electric furnace spectrum of hafnium, and by analogy with the known regularities in the similar spectra Ti I[4] and Zr I[5]. At this time the complexities in Hf I were evident; the search for significant wave-number intervals of low terms had to be made with differences greater than 2000 cm^{-1} . Thus the two leading intervals in the ground term a^3F , 2356.6 cm^{-1} and 2211.0 cm^{-1} , were detected. It was recognized that extension and confirmation of these first regularities would require further improvements in the basic descriptions of hafnium spectra and, also, observation of the Zeeman effect. Both requirements were partially met in 1932 when hafnium spectra were reobserved with purified oxide donated by G. von Hevesey, and the first Zeeman-effect spectrograms were made with a small rod of hafnium metal condensed on a tungsten filament, presented for this purpose by G. Holst of Eindhoven. The arc and spark spectra were remeasured, and extended from 1990 Å to 10637 Å. This list included nearly 1400 lines of Hf I. Magnetic splitting was also observed for 70 Hf I lines. The earlier regularities were fully confirmed. At this point, Meggers and Scribner

turned their attention to Hf II and published their analysis of this spectrum in 1934[6] with the statement that "Further data and analysis of the Hf I spectrum will be published after they have been supplemented by additional observations of Zeeman effects, since the data at present available have proven insufficient for the complete identification of Hf I spectral terms."

Attempts to improve the description of the Hf I spectrum presented serious difficulties because of the presence of many metallic impurity lines as well as strong background HfO spectra. Finally, in 1958, C. H. Corliss and Meggers [7] succeeded in overcoming these complications by using "electrodeless metal-halide lamps excited at relatively low pressure and temperature, by microwaves." This light source was fully described in 1953 by C. H. Corliss, W. R. Bozman, and F. O. Westfall [8], "who showed that a bright emission spectrum of any metal could be obtained from outgassed quartz tubes inclosing a minute amount of any volatile compound of that metal when excited by microwaves."

"Lamps of hafnium iodide, hafnium bromide, and hafnium chloride were compared" to detect atomic hafnium lines common to the different lamps. This "Improved Description of Hafnium Spectra" extends from 1284 Å to 12043 Å and includes some 6200 lines in all as compared with the total of 2400 lines observed earlier.

When the present writer (CEM) requested data on Hf I for inclusion in Volume III of "Atomic Energy Levels," [9] about 1957, Meggers generously provided all of his results to date, but he did not yet have the complete 1958 line list available. In August 1949, greatly improved Zeeman spectrograms were obtained, by courtesy of G. R. Harrison, with the Bitter Magnet at the Massachusetts Institute of Technology. These spectrograms were supplemented from 5000 Å to 9000 Å by later

¹ Figures in brackets indicate the literature references at the end of this paper.

ones taken by C. H. Corliss at the National Bureau of Standards, with a hafnium-iodide lamp as source. The beautiful standard patterns in Hf I and Hf II, reproduced in the 1958 paper on page 270, are from these Bureau spectrograms.

With the help from the Zeeman data, Meggers had classified approximately 2000 lines from his unpublished line list having the short-wave limit 1917 Å. His unpublished analysis at that time included 7 low even terms, 90 miscellaneous even levels, 16 odd terms, 58 miscellaneous odd levels and 132 g-values. These are recorded in reference [9]. All subsequent work on the analysis is based almost entirely on the description published in 1958.

He continued his study of Hf I with the aid of electronic computers until his death in 1966. At this time the material was turned over to C. E. Moore, with the request that she complete the unfinished work on which he had toiled for so many years. This assignment was accepted very reluctantly, with the feeling that it was an obligation she owed to her colleague, but, also, with the full realization that it would be a difficult task.

A square array had been prepared by electronic computer by W. R. Bozman, and a printout of the line list made by J. Sugar contained the classified lines as entered by Meggers, assisted by Isabel D. Murray. The line list totaled some 4700 lines of which about 2800 or 60 percent were classified.

From the regularities already known, it was obvious that Meggers intended to carry the analysis much further on the basis of LS-coupling, by analogy with Ti I and Zr I and with the help from Zeeman data. Consequently, the work has been carried forward with the terms arranged by configurations exactly according to his plan. A serious problem was to determine how completely the Zeeman observations had been utilized in obtaining final g-values. Many resolved patterns had been used to derive the g-values recorded in the 1966 list of levels. The writer was, however, unable to locate a complete summary of g-values similar to the meticulously prepared list Meggers left for Yb II, for example. With the idea that more g-values could be obtained from the original observations, she examined the observing books of Zeeman data, recorded all observed patterns in a duplicate ledger of the line list, and derived as complete a set of g-values as possible. There are now 198 levels for which g-values are known as compared with about 137 listed in 1966. The details of the reduction are described below.

2. The Analysis

Throughout the work on extending the analysis, a great effort has been made to differentiate between the assignments by Meggers and those added later by the writer. When a complete square array by terms had been prepared, and the combining properties of the levels with regard to intensity, limit terms and g-values were studied, it was evident that some of the earlier tentative designations needed revision.

The term and configuration assignments finally adopted are given in tables 1 and 2, for even and odd terms, respectively. The tables are arranged similarly, with the terms grouped by configuration. The successive columns give the configuration, term designation, J-value, level, interval, observed g-value, Landé g-value, number of combinations, and notes described at the end of table 1. Every user is requested to give serious attention to these notes. They have been devised to show as explicitly as possible how far the analysis had been carried by Meggers in 1966 in contrast to additions and revisions made by the writer in order to present a less fragmentary interpretation. The same notes apply to tables 2, 4, and 5.

All levels having note "a" were found by Meggers so far as can be ascertained, and those noted as "b" by the writer. Note "c" is particularly important; it signifies that the configuration and term assignments were by Meggers. Notes "e, f, g" indicate changes made in Meggers' lists. To summarize, notes "a, c" represent Meggers' work, "b, d" indicate interpretation by the writer, and other notes are intermediate in type.

In general, many intervals are irregular, which is not surprising for this complex spectrum in which both sets of levels, odd and even, overlap in position. The LS-coupling does not hold for the more complex configurations. The present terms have been assembled on the basis of their combining properties, intensities of the combinations, and g-values. Many designations are subject to question and may well need revision. For example, the level 25678.61 cm⁻¹ is very low for the ¹F term in the configuration 5d³(¹F)6s, but the combinations are good. Similarly, the level 42061.60 cm⁻¹ ascribed to ³D₃ in the configuration 5d 6s²(¹D)7s has a g-value of 0.832? based on one observation. This g-value, if correct, fits ³G₃ and the line in question may be masked. Further search for this ³D₃ level has been fruitless. There is, also, no check on the level 28586.39 cm⁻¹ designated as ³P₁, which is based on only two combinations. The levels ³G₂ and ³G₆, also need further confirmation. Colons following the level values in tables 1 and 2 indicate dubious entries. The number of combinations listed in column 8 also provide a check on the reliability of the level.

A number of gaps still exist in completing the various groups of terms. This is regrettable, but at present further searching by hand is not rewarding.

An array of observed and predicted terms of Hf I is presented in table 3. This table is condensed in form, but it is designed for use by comparison with tables 1 and 2. Predicted terms are entered only for those configurations having some observed terms. Many predicted terms could be added, as shown, for example, in the array given on page xxii of reference [9]. The line list is not exhausted (see table 8), but most of the leading lines have been classified (see sec. 6).

Because of the complications that arise when an attempt is made to carry the LS-coupling scheme

as far as was evidently planned by Meggers, the writer has repeated the term lists (tables 1 and 2), by level, in the general format that Meggers was using in the course of his work on the analysis. All levels are tabulated in numerical order in tables 4 and 5. Table 4 contains the even levels, 164 in all. Table 5 gives the odd levels, which total 159.

In each table the respective columns list the J -value, the level value (cm^{-1}), the notes described at the end of table 1, and the number of combinations. A single note, "a" or "b" in column 4 indicates the miscellaneous levels, *i.e.*, those not yet assigned a term designation. The number of levels totals 323 of which all but 26 were found by Meggers.

3. The Ionization Limit

No good series are known as yet in Hf I. By using the term $5d^26s^2a\ ^3F_4$ and the center of gravity of the terms ascribed to $5d^2(a\ ^3F_4)6s\ 7s$ as series terms, J. Sugar as calculated an ionization limit of $54700 \pm 600 \text{ cm}^{-1}$ by methods described in reference[10]. With the conversion factor 0.000123981, the ionization potential is $6.78 \pm 0.07 \text{ eV}$.

An experimental value of the ionization potential of Hf I, $6.65 \pm 0.1 \text{ eV}$, obtained by an electron impact method, has been reported by E. G. Rauh and R. J. Ackerman[11]. This value agrees well with the spectroscopic value derived above.

4. Observed g-Values

A test of the correctness of the interpretation and of the accuracy of the Zeeman data is to be found if the g -sum rule of Pauli is applied. As Meggers stated in the paper on Hf II[6], this rule "is expected to be valid for all spectra no matter what the nature of the vector coupling may be." It should be applied to complete groups.

A comparison of observed and Landé g -values for LS-coupling is given for the leading even terms in table 6, and similarly, for the odd terms in table 7. The Landé values are taken from the detailed "Tables of Theoretical Zeeman Effects"[12] published by C. C. Kiess and W. F. Meggers in 1928.

The terms are arranged by configuration and the g -sums are given for each J -value in the separate groups. The agreement is excellent for the low groups in each table. The remaining configurations show larger deviations, as is to be expected, since the groups are not so complete, some designations are open to question, and there is a departure from LS-coupling. These factors are inherent in such a complex spectrum.

In general, these results are a real tribute to Meggers, whose splendid observations and measurements are revealed. In these tables only a few dubious g -values are entered and these are marked with a colon.

5. The Zeeman Observations:

The history of the Zeeman observations has been described above briefly, and need not be repeated here. In averaging the final g -values from the individual Zeeman observations triple weight was given to the best fully-resolved patterns, double weight to many other resolved patterns and less weight to those that were not resolved. With the final averages thus obtained for as many levels as possible, the remaining blended patterns were carefully examined. For classified lines having an observed g -value for one level, this value was used to derive the g -value for the other level, on the assumption that the strongest component had been observed in the unresolved pattern.

The final observed Zeeman data are given in appendix A where the separate columns contain: (1) Wavelength, (2) Intensity (Tube), (3) Intensity (Spark), (4) Classification, (5) Type of Pattern, (6) Δg , (7) 1st g , (8) 2nd g , (9) the strong p -component, and (10) the strong n -component. The Zeeman type is quoted mostly from reference [7], but some have been taken directly from the observing books. The observed g -values used as described above for blended or unresolved patterns are entered in parentheses. The "1st g " refers to the first entry in column 4, *i.e.*, the lower level of the transition. The "2nd g " refers to the higher level involved. The respective J -values are given as subscripts in column 4. The Zeeman effect has been observed for 531 lines.

6. The Classified Lines

Appendix B contains the final list of observed and classified lines. Meggers' line list of 1966 contained more than 4700 lines in which 3217 classifications are entered. There are 88 lines which are blends having 2 classifications. The number of classified lines is, therefore, 3129 or roughly 67 percent of the total.

The successive columns contain: (1) Wavelength, (2) Intensity (Arc or Tube), (3) Intensity (Spark), (4) Wave number (cm^{-1}), (5) Wave number o-c (cm^{-1}), (6) Classification. The levels involved in the transition are entered in whole numbers, with the respective J -values as subscripts. The "odd" level of the transition is in italics.

The observed data are mostly from reference [7]. In column 2 "Z" has been added for the lines having an observed Zeeman effect. For these lines, the Zeeman data are given in appendix A.

The leading unclassified lines are listed in table 8. Lines of intensity 30 or greater are included, and the total number is 31. They are taken from appendix B. The wavelengths and intensities are entered in this table with "Z" added in column 2 for those lines having an observed Zeeman effect (app. A).

7. Acknowledgments

Throughout the years since W. F. Meggers envisaged a Monograph on Hf I, a number of colleagues have generously supported the effort. W. R. Bozman and J. Sugar assisted with the computer preparation of the square array and line list which have been used in bringing the work to its present conclusion. The late Ruth Peterson furnished the latest revised computer list of the energy levels. Much of the careful editing of the final list of classified lines was ably handled by the late Isabel D. Murray. The generous contributions of all who have participated in the work and helped to make this publication a tribute to W. F. Meggers are gratefully acknowledged. The writer is especially indebted to her husband, B. W. Sitterly, for his cordial cooperation throughout the years.

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Washington, D.C.
December 9, 1975

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TABLE 1. Even Terms of Hf I

Configuration	Desig.	J	Level	Interval	Obs. g	Landé g	No. Comb.	Notes
$5d^2 6s^2$	$a ^3F$	2	0.00	2356.68 2210.96	0.696	0.667	67	<i>a, c</i>
		3	2356.68		1.082	1.083	70	<i>a, c</i>
		4	4567.64		1.240	1.250	52	<i>a, c</i>
$5d^2 6s^2$	$a ^3P$	0	5521.77	1050.77 2411.20	0.000	%	28	<i>a, c</i>
		1	6572.54		1.496	1.500	56	<i>a, c</i>
		2	8983.74		1.300	1.500	86	<i>a, c</i>
$5d^2 6s^2$	$a ^1G$	4	10532.55		1.007	1.000	59	<i>a, c</i>
$5d^2 6s^2$	$a ^1D$	2	5638.61		1.164	1.000	85	<i>a, c</i>
$5d^2 6s^2$	$a ^1S$	0	25444.37			%	9	<i>a, c</i>
$5d^3(b ^4F)6s$	$a ^5F$	1	14092.26	648.41 932.65 1093.28 1134.68	0.010	0.000	46	<i>a, c</i>
		2	14740.67		1.007	1.000	60	<i>a, c</i>
		3	15673.32		1.248	1.250	63	<i>a, c</i>
		4	16766.60		1.341	1.350	47	<i>a, c</i>
		5	17901.28		1.383	1.400	24	<i>a, c</i>
"	$b ^3F$	2	23327.71	1954.11 1792.68		0.667	38	<i>a, c</i>
		3	25281.82		0.902	1.083	37	<i>a, c</i>
		4	27074.50		1.144	1.250	22	<i>a, c</i>
$5d^3(b ^4P)6s$	$a ^5P$	1	20784.87	123.56 1290.65	2.40	2.500	27	<i>a, c</i>
		2	20908.43			1.833	41	<i>a, c</i>
		3	22199.08		1.734	1.667	25	<i>a, c</i>
"	$b ^3P$	0		-327.44		%		
		1	28527.98		1.222	1.500	18	<i>a, c</i>
		2	28200.54		1.393	1.500	24	<i>a, c</i>
$5d^3(a ^2H)6s$	$a ^3H$	4	26922.72:	96.03 -74.80		0.800	4	<i>b, d</i>
		5	27018.75			1.033	17	<i>a, c</i>
		6	26943.95			1.167	7	<i>a, c</i>
"	1H	5				1.000		
		3	22880.24	372.57 832.33	0.802:	0.750	44	<i>a, c</i>
		4	23252.81		1.028	1.050	32	<i>a, c</i>
"	$a ^3G$	5	24085.14		1.142	1.200	23	<i>a, c</i>
		4				1.000		
		2	31119.20	-64.56 521.04	0.889	0.667	15	<i>a, c</i>
$5d^3(b ^2F)6s$	$c ^3F$	3	31054.64		1.085	1.083	17	<i>a, c</i>
		4	31575.68		1.150	1.250	11	<i>a, c</i>
		3	25678.61			1.000	29	<i>a, d</i>
"	$a ^1F$	1	26918.13	-1833.97 1631.22		0.500	21	<i>a, c</i>
		2	25084.16			1.167	37	<i>a, c</i>
		3	26715.38		1.223	1.333	25	<i>a, c</i>
"	$b ^1D$	2	31619.97		1.007	1.000	16	<i>a, e</i>

TABLE I. Even Terms of Hf I—Continued

Configuration	Desig.	J	Level	Interval	Obs. g	Landé g	No. Comb.	Notes
$5d^3(b\ ^2P)6s$	$c\ ^3P$	0				%		
		1				1.500		
		2	30146.40		1.371	1.500	22	a, c
"	$a\ ^1P$	1	32091.60		1.167	1.000	11	a, e
$5d^3(^2D)6s$	$b\ ^3D$	1	34991.64		0.505	0.500	15	a, e
		2	35115.29	123.65	1.110	1.167	19	a, g
		3	36523.84	1408.55	1.265	1.333	11	a, e
"	$c\ ^1D$	2	38289.39		1.085	1.000	16	a, f
$6p^2(^3P)5d(^4F)6s$	$c\ ^5F$	1	39790.69		0.591	0.000	12	a, c
		2	40636.28	845.59	1.065	1.000	20	a, c
		3	41475.84	839.56	1.277	1.250	23	a, c
		4	42670.82	1194.98	1.237	1.350	14	a, c
		5				1.400		
"	$e\ ^3F$	2	45666.16			0.667	10	a, c
		3	45994.61	328.45	0.631:	1.083	14	a, c
		4	45387.51	-607.10	1.021:	1.250	14	a, c
$6p^2(^3P)5d(^4D)6s$	$b\ ^5D$	0				%		
		1	42782.54		1.530	1.500	11	a, c
		2	43016.46	233.92		1.500	21	a, c
		3	43013.02:	-3.44		1.500	3	b, d
		4	43838.33	825.31	1.295	1.500	13	a, c
"	$e\ ^3D$	1	42111.71		0.756	0.500	13	a, c
		2	42719.58	607.87	1.182	1.167	17	a, c
		3	42360.88	-358.70	1.143	1.333	15	a, c
$6p^2(^3P)5d(^4P)6s$	$b\ ^5P$	1	46100.78		2.117	2.500	10	a, e
		2	45254.92	-845.86	1.038:	1.833	18	a, c
		3	45364.84	109.92		1.667	18	a, c
"	$f\ ^3P$	0				%		
		1	45474.61		1.420	1.500	10	a, c
		2	46437.73	963.12		1.500	24	a, c
$6p^2(^3P)5d(^2F)6s$	$f\ ^3F$	2	46056.19		0.696	0.667	15	a, c
		3	45649.36	-406.93	1.178	1.083	22	a, c
		4	46282.36	633.00	1.235	1.250	21	a, c
"	$b\ ^1F$	3	45083.30			1.000	18	a, c
$6p^2(^3P)5d(^2D)6s$	$c\ ^3D$	1	37336.20		0.487	0.500	9	a, c
		2	37038.84	-297.36	1.084	1.167	16	a, c
		3	39127.64	2088.80	1.316	1.333	16	a, c
"	$d\ ^1D$	2	40130.23		1.211	1.000	21	a, d
$6p^2(^3P)5d(^2P)6s$	$d\ ^3P$	0				%		
		1	43561.77		1.467	1.500	15	a, c
		2	44375.44	813.67	1.335	1.500	24	a, c
"	$b\ ^1P$	1	46782.78			1.000	11	a, d

Table 1. Even Terms of Hf I—Continued

Configuration	Desig.	J	Level	Interval	Obs. g	Landé g	No. Comb.	Notes
$6p^2(^1D)5d(^2G)6s$	$b\ ^3G$	3	47345. 93	-353. 55 776. 27	1. 142	0. 750	26	<i>a, c</i>
		4	46992. 38			1. 050	18	<i>a, c</i>
		5	47768. 65			1. 200	6	<i>a, c</i>
"	$b\ ^1G$	4	47606. 23		0. 97:	1. 000	15	<i>a, c</i>
$6p^2(^1D)5d(^2F)6s$	$g\ ^3F$	2	46961. 96	-681. 67 397. 86		0. 667	23	<i>a, c</i>
		3	46280. 29			1. 083	19	<i>a, c</i>
		4	46678. 15			1. 250	14	<i>a, c</i>
"	$c\ ^1F$	3	46966. 62			1. 000	22	<i>a, c</i>
$6p^2(^1D)5d(^2D)6s$	$f\ ^3D$	1	47874. 42	-569. 43 -192. 62	1. 478	0. 500	15	<i>a, c</i>
		2	47304. 99			1. 167	27	<i>a, c</i>
		3	47112. 37			1. 333	14	<i>a, c</i>
"	$f\ ^1D$	2	47702. 42			1. 000	15	<i>a, c</i>
$6p^2(^1D)5d(^2P)6s$	$g\ ^3P$	0	47751. 22	-441. 92 558. 35	1. 529	%	6	<i>b, d</i>
		1	47309. 30			1. 500	14	<i>a, c</i>
		2	47867. 65			1. 500	10	<i>a, d</i>
"	$c\ ^1P$	1	48129. 58			1. 000	11	<i>a, c</i>
$6p^2(^1D)5d(^2S)6s$	3S	1				2. 000		
"	1S	0				%		
$6p^2(^1S)5d(^2D)6s$	$g\ ^3D$	1	48309. 88	-354. 69 -58. 29		0. 500	8	<i>a, d</i>
		2	47955. 19			1. 167	24	<i>a, c</i>
		3	47896. 90			1. 333	15	<i>a, c</i>
"	$g\ ^1D$	2	48407. 25			1. 000	23	<i>a, c</i>
$5d\ 6s^2(a\ ^2D)7s$	$d\ ^3D$	1	39546. 34	967. 19 1548. 07	0. 815 0. 832:	0. 500	12	<i>a, f</i>
		2	40513. 53			1. 167	23	<i>a, f</i>
		3	42061. 60:			1. 333	14	<i>a, f</i>
"	$e\ ^1D$	2	46183. 08		0. 942	1. 000	22	<i>a, f</i>
$5d^2(^3F)6s(a\ ^4F)7s$	$b\ ^5F$	1	39286. 18	502. 72 1093. 18 1401. 46 1848. 48	0. 216 1. 009 1. 230 1. 353	0. 000	18	<i>a, c</i>
		2	39788. 90			1. 000	18	<i>a, c</i>
		3	40882. 08			1. 250	17	<i>a, c</i>
		4	42283. 54			1. 300	16	<i>a, c</i>
		5	44132. 02			1. 400	9	<i>a, c</i>
"	$d\ ^3F$	2	41298. 36	2190. 93 1288. 24	0. 826 1. 196: 1. 248	0. 667	27	<i>a, c</i>
		3	43489. 29			1. 083	23	<i>a, c</i>
		4	44777. 53			1. 250	19	<i>a, c</i>
$5d^2(^3P)6s(a\ ^4P)7s$	$c\ ^5P$	1	46937. 92	-77. 18 1077. 70	1. 285: 1. 33:	2. 500	9	<i>a, d</i>
		2	46860. 74			1. 833	15	<i>a, e</i>
		3	47938. 44			1. 667	19	<i>a, d</i>

TABLE I. Even Terms of Hf I—Continued

Configuration	Desig.	J	Level	Interval	Obs. g	Landé g	No. Comb.	Notes
$5d^2(^3P)6s(a ^4P)7s$	<i>e</i> 3P	0	44940.00:	330.13 458.48	1.376	% 1.500 1.500	4 15 16	<i>b, d</i> <i>a, e</i> <i>a, d</i>
		1	45270.13					
		2	45728.61					
$5d^2(^3F)6s(a ^2F)7s$	<i>i</i> 3F	2	48459.08	287.43 258.85		0.667 1.083 1.250	14 16 20	<i>a, d</i> <i>a, d</i> <i>a, d</i>
		3	48746.51					
		4	49005.36					
"	<i>d</i> 1F	3	48049.44			1.000	16	<i>a, d</i>
$5d^2(^1D)6s(b ^3D)7s$	3D	1				0.500		
		2				1.167		
		3				1.333		
"	1D	2				1.000		
$5d^2(^3P)6s(a ^2P)7s$	3P	0				%		
		1					1.500	
		2					1.500	
"	1P	1				1.000		
$5d^2(^1G)6s(a ^2G)7s$	3G	3				0.750		
		4				1.050		
		5				1.200		
"	1G	4				1.000		
$5d^4$	<i>a</i> 5D	0	39843.86	774.77 592.39 528.37 436.23	1.511 1.444 1.338 1.281	0/0 1.500 1.500 1.500 1.500	4 11 18 21 14	<i>a, c</i> <i>a, c</i> <i>a, c</i> <i>a, c</i> <i>a, c</i>
		1	40618.63					
		2	41211.02					
		3	41739.39					
		4	42175.62					
$5d^4$	<i>b</i> 3H	4	48022.20	1158.46 1708.10		0.800 1.033 1.167	15 9 3	<i>a, c</i> <i>a, c</i> <i>b, d</i>
		5	49180.66					
		6	50888.76:					
$5d^4$	<i>c</i> 3G	3	48598.99	−242.07 1183.73	0.505:	0.750 1.050 1.200	18 14 11	<i>a, d</i> <i>a, c</i> <i>a, c</i>
		4	48356.92					
		5	49540.65					
$5d^4$	<i>h</i> 3F	2	48991.42	−121.97 −648.71		0.667 1.083 1.250	26 23 17	<i>a, c</i> <i>a, c</i> <i>a, c</i>
		3	48869.45					
		4	48220.74					
$5d^4$	<i>h</i> 3D	1	48982.17:	−24.25 −96.65		0.500 1.167 1.333	9 13 14	<i>a, d</i> <i>a, g</i> <i>a, c</i>
		2	48906.42					
		3	48809.77					
$5d^4$	3P	0				0/0		
		1				1.500		
		2				1.500		

TABLE 1. *Even Terms of Hf I—Continued*

Configuration	Desig.	<i>J</i>	Level	Interval	Obs. <i>g</i>	Landé <i>g</i>	No. Comb.	Notes
Miscellaneous Levels								
		3	46181. 42				12	<i>a</i>
		2	48179. 12				14	<i>a</i>
		3	48319. 12				23	<i>a</i>
		2	48552. 34				13	<i>a</i>
		2	48594. 81				21	<i>a</i>
	⁵ P?	2	48708. 44		1. 857		24	<i>a, e</i>
	⁵ F?	5	49178. 34:				4	<i>b</i>
		3	49347. 30		1. 304		20	<i>a, e</i>
		2	49403. 97				14	<i>a</i>
		2	49438. 81				10	<i>a</i>
		1	49446. 83				8	<i>a</i>
		4	49623. 42				18	<i>a</i>
		3	49660. 56				26	<i>a</i>
		3	49791. 86				24	<i>a</i>
		3	49999. 13		1. 398		11	<i>a</i>
		2	50193. 24				17	<i>a</i>
		5	50279. 54				9	<i>a</i>
		4	50393. 21				14	<i>a</i>
	³ F?	3	50680. 42		1. 146:		10	<i>a</i>
		1	50828. 57:				8	<i>a</i>
		2	50891. 34				9	<i>a</i>
		1	51091. 22				7	<i>a</i>
	¹ G	4	51201. 45				11	<i>a</i>
	⁵ F	4	51390. 77				10	<i>b</i>
		3	51395. 73				20	<i>a</i>
		5	51408. 67				16	<i>a</i>
		2	51508. 36				10	<i>a</i>
		3	51556. 21				12	<i>b</i>
		4	51640. 33				12	<i>a</i>
		2	51771. 56				10	<i>a</i>
		2	51782. 92				8	<i>a</i>
		3	51847. 43				11	<i>a</i>
		5	51929. 94				10	<i>a</i>

Notes to Tables 1 to 4

a Level found by W. F. Meggers.*b* Level new; added by C. E. Moore.*c* Configuration and term designation assigned by W. F. Meggers.*d* Configuration and term designation assigned by C. E. Moore.*e* Configuration and term designation by W. F. Meggers changed in present work.*f* Configuration by W. F. Meggers changed in present work.*g* Term designation by W. F. Meggers changed in present work.

TABLE 2. Odd Terms of Hf I

Configuration	Desig.	J	Level	Interval	Obs. g	Landé g	No. Comb.	Notes
$5d\ 6s^2(a\ ^2D)6p$	$z\ ^3F^o$	2	14435. 12	106. 54 3683. 31	0. 903	0. 667	72	a, c
		3	14541. 66		1. 085	1. 083	68	a, c
		4	18224. 97		1. 246	1. 250	30	a, c
	$z\ ^3D^o$	1	14017. 81	2145. 54 2218. 15	0. 542	0. 500	57	a, c
		2	16163. 35		1. 172	1. 167	77	a, c
		3	18381. 50		1. 287	1. 333	68	a, c
	$z\ ^3P^o$	0	18270. 12	-126. 73 1647. 90	0. 000	%	11	a, c
		1	18143. 39		1. 428	1. 500	46	a, c
		2	19791. 29		1. 414	1. 500	56	a, c
	$z\ ^1F^o$	3	23644. 74		1. 074	1. 000	56	a, c
	$z\ ^1D^o$	2	10508. 88		0. 805	1. 000	70	a, c
	$z\ ^1P^o$	1	26463. 93		0. 996	1. 000	35	a, c
$5d^2(a\ ^3F)6s(a\ ^4F)6p$	$z\ ^5G^o$	2	18011. 04	1281. 64 1667. 42 1941. 26 2560. 73	0. 394	0. 333	48	a, c
		3	19292. 68		0. 952	0. 917	69	a, c
		4	20960. 10		1. 157	1. 150	32	a, c
		5	22901. 36		1. 276	1. 267	19	a, c
		6	25462. 09		1. 38:	1. 333	4	a, c
	$z\ ^5F^o$	1	21738. 70	711. 84 998. 06 1336. 64 1417. 29	0. 030	0. 000	40	a, c
		2	22450. 54		1. 011	1. 000	58	a, c
		3	23448. 60		1. 204	1. 250	59	a, c
		4	24785. 24		1. 330	1. 350	35	a, c
		5	26202. 53		1. 357	1. 400	22	a, c
	$z\ ^5D^o$	0	24966. 78	227. 70 439. 72 671. 58 1210. 62	0. 000	%	10	a, c
		1	25194. 48		1. 447	1. 500	31	a, c
		2	25634. 20		1. 418	1. 500	52	a, c
		3	26305. 78		1. 396	1. 500	57	a, c
		4	27516. 40		1. 474	1. 500	42	a, c
$5d^2(a\ ^3P)6s(a\ ^4P)6p$	$z\ ^3G^o$	3	28583. 69	662. 96 1730. 35	0. 940	0. 750	51	a, c
		4	29246. 65		1. 071	1. 050	35	a, c
		5	30977. 00		1. 213	1. 200	22	a, c
	$y\ ^3F^o$	2	27149. 64	504. 69 3078. 90	0. 993	0. 667	50	a, c
		3	27654. 33		1. 157	1. 083	49	a, c
		4	30733. 23		1. 277	1. 250	32	a, c
	$y\ ^3D^o$	1	28790. 24	-522. 84 1729. 42	0. 966	0. 500	24	a, c
		2	28267. 40		1. 139	1. 167	45	a, c
		3	29996. 82		1. 232	1. 333	49	a, c
	$y\ ^5D^o$	0	27231. 74	302. 00 2219. 11 1589. 65 600. 81	%	10	a, c	
		1	27533. 74		1. 264	1. 500	31	a, g
		2	29752. 85		1. 498	1. 500	40	a, c
		3	31342. 50		1. 387	1. 500	35	a, c
		4	31943. 31		1. 401	1. 500	35	a, c

TABLE 2. Odd Terms of Hf I—Continued

Configuration	Desig.	J	Level	Interval	Obs. g	Landé g	No. Comb.	Notes
$5d^2(a^3P)6s(a^4P)6p$	$z\ ^5P^\circ$	1	31952. 25	1169. 23 17. 65	2. 080	2. 500	20	a, c
		2	33121. 48		1. 342	1. 833	27	a, c
		3	33139. 13		1. 441	1. 667	42	a, c
	$z\ ^5S^\circ$	2	31943. 82	1810. 06 1661. 91	1. 594	2. 000	31	a, c
		1	33137. 89		0. 772	0. 500	22	a, c
		2	34947. 95		1. 164	1. 167	24	a, c
	$x\ ^3D^\circ$	3	36609. 86		1. 256	1. 333	24	a, c
		0	28526. 20	60. 19 815. 06	0. 000	%	6	a, c
		1	28586. 39:			1. 500	2	b, d
		2	29401. 45		1. 748	1. 500	41	a, c
	$z\ ^3S^\circ$	1	28047. 91		1. 930	2. 000	26	a, c
$5d^2(a^3F)6s(a^2F)6p$	$y\ ^3G^\circ$	3	32533. 32	1461. 39 1999. 02	0. 951	0. 750	40	a, c
		4	33994. 71		1. 031	1. 050	23	a, c
		5	35993. 73		1. 130	1. 200	17	a, c
	$x\ ^3F^\circ$	2	33538. 14	411. 14 2125. 76	0. 821	0. 667	26	a, c
		3	33949. 38		1. 088	1. 083	28	a, c
		4	36075. 04		1. 063	1. 250	22	a, c
	$w\ ^3D^\circ$	1	34596. 47	2176. 38 1634. 95	0. 970	0. 500	16	a, c
		2	36772. 85		1. 153	1. 167	18	a, c
		3	38407. 80		1. 296	1. 333	14	a, c
	$z\ ^1G^\circ$	4	38987. 85		1. 142	1. 000	19	a, e
	$y\ ^1F^\circ$	3	34877. 04		0. 955	1. 000	31	a, c
	$y\ ^1D^\circ$	2	31610. 80		1. 004	1. 000	35	a, c
$5d^2(b^1D)6s(b^2D)6p$	$v\ ^3F^\circ$	2	40194. 45	2910. 25 2216. 79	0. 511	0. 667	14	a, f
		3	43104. 70		1. 078	1. 083	12	a, d
		4	45321. 49			1. 250	9	b, d
	$v\ ^3D^\circ$	1	36949. 27	1376. 19 868. 46	0. 531	0. 500	9	a, f
		2	38325. 46		1. 153	1. 167	14	a, c
		3	39193. 92		1. 283	1. 333	19	a, c
	$x\ ^3P^\circ$	0	37843. 71	308. 01 1283. 47	0. 000	%	2	b, d
		1	38151. 72		1. 433	1. 500	8	a, c
		2	39435. 19		1. 355	1. 500	10	a, c
	$x\ ^1F^\circ$	3	36237. 34		1. 047	1. 000	20	a, c
	$x\ ^1D^\circ$	2	41768. 67		0. 926	1. 000	12	a, d
	$y\ ^1P^\circ$	1	35284. 32		1. 061	1. 000	15	a, g

TABLE 2. Odd Terms of Hf I—Continued

Configuration	Desig.	J	Level	Interval	Obs. g	Landé g	No. Comb.	Notes
$5d^2(a^3P)6s(a^2P)6p$	u^3D^o	1	39704. 40	562. 92 500. 11	0. 618	0. 500	10	a, d
		2	40267. 32		1. 082	1. 167	15	a, c
		3	40767. 43		1. 215	1. 333	11	a, c
	w^3P^o	0	41133. 80	60. 14 881. 87	0. 000	%	2	b, d
		1	41193. 94		1. 319	1. 500	11	a, d
		2	42075. 81		1. 232	1. 500	10	a, d
	$^3S^o$	1				2. 000		
	w^1D^o	2	43517. 82		0. 997	1. 000	13	a, d
	x^1P^o	1	40704. 12		1. 153	1. 000	8	a, d
	$^1S^o$	0				%		
$5d^2(a^1G)6s(a^2G)6p$	z^3H^o	4	34805. 90	1613. 36 882. 33	0. 992	0. 800	19	a, e
		5	36419. 26		1. 118	1. 033	14	a, c
		6	37301. 59		1. 15:	1. 167	6	a, d
	x^3G^o	3				0. 750		
		4	36850. 04	1995. 41	1. 062	1. 050	20	a, e
		5	38845. 45		1. 208	1. 200	12	a, c
	w^3F^o	2	33994. 86	1458. 96 1816. 02	0. 934	0. 667	24	a, f
		3	35453. 82		1. 002	1. 083	32	a, f
		4	37269. 84		1. 165	1. 250	21	a, g
	z^1H^o	5	42166. 60:			1. 000	2	b, d
	y^1G^o	4	42453. 70		1. 034	1. 000	7	a, c
	w^1F^o	3	42395. 66		1. 062	1. 000	14	a, c
$5d^3(b^4F)6p$	y^5G^o	2	40957. 53:	464. 91 448. 56 1666. 49 586. 90	0. 78:	0. 333	8	a, c
		3	41422. 44		0. 934	0. 917	11	a, c
		4	42871. 00		1. 144	1. 150	9	a, c
		5	44537. 49		1. 247	1. 267	6	a, c
		6	45124. 39:		1. 326	1. 333	1	a, c
	y^5F^o	1	43786. 59	717. 13 608. 50 1177. 46 1077. 18	0. 170	0. 000	9	a, c
		2	44503. 72		1. 014	1. 000	6	a, c
		3	45112. 22			1. 250	12	a, c
		4	46289. 68		1. 269	1. 350	8	a, c
		5	47366. 86		1. 310	1. 400	7	b, d
	x^5D^o	0	45533. 45	266. 04 370. 62 900. 56 977. 23	%	3	b, d	
		1	45799. 49		1. 426	1. 500	8	a, d
		2	46170. 11			1. 500	9	a, d
		3	47070. 67			1. 500	9	a, d
		4	48047. 90			1. 500	10	a, d

TABLE 2. Odd Terms of HfI—Continued

Configuration	Desig.	J	Level	Interval	Obs. g	Landé g	No. Comb.	Notes
$5d^3(b\ ^4F)6p$	$w\ ^3G^\circ$	3	46775. 95	1460. 22 1153. 27		0. 750	7	<i>a, d</i>
		4	48236. 17			1. 050	10	<i>a, d</i>
		5	49389. 44			1. 200	6	<i>a, d</i>
	$t\ ^3F^\circ$	2	50084. 58	269. 94 226. 71		0. 667	8	<i>a, d</i>
		3	50354. 52			1. 083	9	<i>a, d</i>
		4	52581. 23:			1. 250	8	<i>a, d</i>
	$s\ ^3D^\circ$	1	49204. 11	1675. 22 859. 91		0. 500	7	<i>a, d</i>
		2	50879. 35:			1. 167	4	<i>b, d</i>
		3	51739. 26:			1. 333	4	<i>b, d</i>
$5d^3(b\ ^4P)6p$	$w\ ^5D^\circ$	0	48985. 40	—726. 23 2105. 48 493. 26 1110. 68		%	4	<i>a, d</i>
		1	48259. 17:			1. 500	9	<i>a, d</i>
		2	50364. 65			1. 500	8	<i>b, d</i>
		3	50857. 91			1. 500	7	<i>a, d</i>
		4	51968. 59			1. 500	8	<i>a, d</i>
	$y\ ^5P^\circ$	1	47876. 61	75. 37 —304. 47		2. 500	7	<i>b, d</i>
		2	48951. 98			1. 833	14	<i>a, d</i>
		3	48647. 51			1. 667	8	<i>a, d</i>
	$^5S^\circ$					2. 000		
	$t\ ^3D^\circ$	1	42485. 49		0. 859	0. 500	9	<i>a, d</i>
		2						
		3	44463. 51		1. 292	1. 333	9	<i>a, d</i>
	$v\ ^3P^\circ$	0				%		
		1	42036. 40		1. 229	1. 500	11	<i>a, d</i>
		2				1. 500		
$5d^3(b\ ^2G)6p$	$^3S^\circ$	1				2. 000		
	$y\ ^3H^\circ$	4	49268. 25			0. 800	10	<i>a, d</i>
		5				1. 033		
		6	51641. 85		1. 084:	1. 167	4	<i>b, d</i>
	$v\ ^3G^\circ$	3	47931. 85		0. 828	0. 750	4	<i>b, d</i>
		4				1. 050		
		5				1. 200		
	$u\ ^3F^\circ$	2	42302. 11	—477. 53 —649. 22	0. 861	0. 667	16	<i>a, d</i>
		3	41824. 58		1. 131:	1. 083	19	<i>a, d</i>
		4	41175. 36		1. 203	1. 250	13	<i>a, d</i>
	$^1H^\circ$	5				1. 000		
	$^1G^\circ$	4	43794. 60		1. 038	1. 000	8	<i>a, d</i>
	$^1F^\circ$	3	44049. 25		1. 024:	1. 000	9	<i>a, d</i>

TABLE 2. *Odd Terms of Hf I*—Continued

Configuration	Desig.	<i>J</i>	Level	Interval	Obs. <i>g</i>	Lande' <i>g</i>	No. Comb.	Notes
Miscellaneous Levels								
		1	43844.62		1.363		12	<i>a</i>
		1	44257.57		1.216:		9	<i>a</i>
		2	45138.88				11	<i>a</i>
		3	45455.14				10	<i>a</i>
		3	45522.34				7	<i>a</i>
		2	45848.38				10	<i>a</i>
		3	46218.21				8	<i>a</i>
		1	46460.74				8	<i>b</i>
		2	46981.19				7	<i>a</i>
		1	47092.01				8	<i>a</i>
		2	47345.10				12	<i>a</i>
		3	47590.11		1.346		10	<i>a</i>
		1	47640.24				7	<i>b</i>
		3	47884.71				11	<i>a</i>
		2	47937.90				8	<i>b</i>
		3	48081.48				13	<i>a</i>
		3	50583.62				7	<i>a</i>
		4	53063.82				5	<i>a</i>
		0	53853.61				3	<i>a</i>
		2	57622.92				6	<i>b</i>
		2	58115.27				8	<i>b</i>

TABLE 3. Observed and Predicted Terms of Hf I

Config.	Even Terms	Config.	Odd Terms
$5d^4$	$a\ ^5D$ $^3P\ h\ ^3D\ h\ ^3F\ c\ ^3G\ b\ ^3H$ $^3P\ ^3F$ $^1S\ ^1D\ ^1F\ ^1G\ ^1I$ $^1S\ ^1D\ ^1G$		
$5d^3\ 6s$	$a\ ^5P\ a\ ^5F$ $b\ ^3P\ b\ ^3F$ $c\ ^3P\ a\ ^3D\ c\ ^3F\ a\ ^3G\ a\ ^3H$ $a\ ^1P\ b\ ^1D\ a\ ^1F\ ^1G\ ^1I$ $b\ ^3D$ $c\ ^1D$	$5d^3\ 6p$	$x\ ^5D^\circ\ y\ ^5F^\circ\ y\ ^5G^\circ$ $s\ ^3D^\circ\ t\ ^3F^\circ\ w\ ^3G^\circ$ $^5S^\circ\ y\ ^5P^\circ\ w\ ^5D^\circ$ $^3S^\circ\ v\ ^3P^\circ\ t\ ^3D^\circ$ $u\ ^3F^\circ\ v\ ^3G^\circ\ y\ ^3H^\circ$ $v\ ^1F^\circ\ x\ ^1G^\circ\ ^1H^\circ$
$5d^2\ 6s^2$	$a\ ^3P\ a\ ^3F\ a\ ^3G$ $a\ ^1S\ a\ ^1D\ a\ ^1G$		
$5d^2\ 6s\ 7s$	$c\ ^5P\ b\ ^5F$ $e\ ^3P\ d\ ^3F$ $i\ ^3F$ $d\ ^1F$ $^3P\ ^3D\ ^3G$ $^1P\ ^1D\ ^1D$	$5d^2\ 6s\ 6p$	$z\ ^5D^\circ\ z\ ^5F^\circ\ z\ ^5G^\circ$ $y\ ^3D^\circ\ y\ ^3F^\circ\ z\ ^3G^\circ$ $z\ ^5S^\circ\ z\ ^5P^\circ\ y\ ^5D^\circ$ $z\ ^3S^\circ\ y\ ^3P^\circ\ x\ ^3D^\circ$ $w\ ^3D^\circ\ x\ ^3F^\circ\ y\ ^3G^\circ$ $y\ ^1D^\circ\ y\ ^1F^\circ\ z\ ^1G^\circ$ $x\ ^3P^\circ\ v\ ^3D^\circ\ v\ ^3F^\circ$ $y\ ^1P^\circ\ x\ ^1D^\circ\ x\ ^1F^\circ$ $^3S^\circ\ w\ ^3P^\circ\ u\ ^3D^\circ$ $^1S^\circ\ x\ ^1P^\circ\ w\ ^1D^\circ$ $w\ ^3F^\circ\ x\ ^3G^\circ\ z\ ^3H^\circ$ $w\ ^1F^\circ\ y\ ^1G^\circ\ z\ ^1H^\circ$
$5d\ 6s^2\ 7s$	$d\ ^3D$ $e\ ^1D$	$5d\ 6s^2\ 6p$	$z\ ^3P^\circ\ z\ ^3D^\circ\ z\ ^3F^\circ$ $z\ ^1P^\circ\ z\ ^1D^\circ\ z\ ^1F^\circ$
$5d\ 6s\ 6p^2$	$b\ ^5P\ b\ ^5D\ c\ ^5F$ $f\ ^3P\ e\ ^3D\ e\ ^3F$ $d\ ^3P\ c\ ^3D\ f\ ^3F$ $b\ ^1P\ d\ ^1D\ b\ ^1F$ $^3S\ g\ ^3P\ f\ ^3D\ g\ ^3F\ b\ ^3G$ $^1S\ c\ ^1P\ f\ ^1D\ c\ ^1F\ b\ ^1G$ $g\ ^3D$ $g\ ^1D$		

TABLE 4. Even Levels of Hf I

J	Level	Obs. g	Notes	No. Comb.	J	Level	Obs. g	Notes	No. Comb.
2	0.00	0.696	a, c	67	2	41298.36	0.826	a, c	27
3	2356.68	1.082	a, c	70	3	41475.84	1.277	a, c	23
4	4567.64	1.240	a, c	52	3	41739.39	1.338	a, c	21
0	5521.77	0.000	a, c	28	3	42061.60	0.832:	a, f	14
2	5638.61	1.164	a, c	85	1	42111.71	0.756	a, c	13
1	6572.54	1.496	a, c	56	4	42175.62	1.281	a, c	14
2	8983.74	1.300	a, c	86	4	42283.54	1.353	a, c	16
4	10532.55	1.007	a, c	59	3	42360.88	1.143	a, c	15
1	14092.26	0.010	a, c	46	4	42670.82	1.237	a, c	14
2	14740.67	1.007	a, c	60	2	42719.58	1.182	a, c	17
3	15673.32	1.248	a, c	63	1	42782.54	1.530	a, c	11
4	16766.60	1.341	a, c	47	3	43013.02:	b, d		3
5	17901.28	1.383	a, c	24	2	43016.46	a, c		21
1	20784.87	2.40	a, c	27	3	43489.29	1,196:	a, c	23
2	20908.43	1.734	a, c	41	1	43561.77	1.467	a, c	15
3	22199.08		a, c	25	4	43838.33	1.295	a, c	13
3	22880.24	0.802:	a, c	44	5	44132.02	1.400	a, c	9
4	23252.81	1.028	a, c	32	2	44375.44	1.335	a, c	24
2	23327.71	0.902	a, c	38	4	44777.53	1.248	a, c	19
5	24085.14	1.142	a, c	23	0	44940.00:	b, d		4
2	25084.16		a, c	37	3	45083.30	a, c		18
3	25281.82	1.144	a, c	37	2	45254.92	1.038:	a, c	18
0	25444.37		a, c	9	1	45270.13	1.376	a, e	15
3	25678.61		a, d	29	3	45364.84		a, c	18
3	26715.38	1.223	a, c	25	4	45387.51	1.021	a, c	14
1	26918.13		a, c	21	1	45474.61	1.420	a, c	10
4	26922.72:		b, d	4	3	45649.36	1.178	a, c	22
6	26943.95		a, c	7	2	45666.16		a, c	10
5	27018.75		a, c	17	2	45728.61		a, d	16
4	27074.50		a, c	22	3	45994.61	0.631:	a, c	14
2	28200.54	1.393	a, c	24	2	46056.19	0.696	a, c	15
1	28527.98	1.222	a, c	18	1	46100.78	2.117	a, e	10
2	30146.40	1.371	a, c	22	3	46181.42		a	12
3	31054.64	1.085	a, c	17	2	46183.08	0.942	a, f	22
2	31119.20	0.889	a, c	15	3	46280.29		a, c	19
4	31575.68	1.150	a, c	11	4	46282.36	1.235	a, c	21
2	31619.97	1.007	a, e	16	2	46437.73		a, c	24
1	32091.60	1.167	a, e	11	4	46678.15		a, c	14
1	34991.64	0.505	a, e	15	1	46782.78		a, d	11
2	35115.29	1.110	a, g	19	2	46860.74		a, e	15
3	36523.84	1.265	a, e	11	1	46937.92	1.285:	a, d	9
2	37038.84	1.084	a, c	16	2	46961.96		a, c	23
1	37336.20	0.487	a, c	9	3	46966.62		a, c	22
2	38289.39	1.085	a, f	16	4	46992.38		a, c	18
3	39127.64	1.316	a, c	16	3	47112.37	1.478	a, c	14
1	39286.18	0.216	a, c	18	2	47304.99		a, c	27
1	39546.34	0.815	a, f	12	1	47309.30	1.529	a, c	14
2	39788.90	1.009	a, c	18	3	47345.93		a, c	26
1	39790.69	0.591	a, c	12	4	47606.23	0.97:	a, c	15
0	39843.86		a, c	4	2	47702.42		a, c	15
2	40130.23	1.211	a, d	21	0	47751.22	b, d		6
2	40513.53	1.091	a, f	23	5	47768.65	1.142	a, c	6
1	40618.63	1.511	a, c	11	2	47867.65		a, d	10
2	40636.28	1.065	a, c	20	1	47874.42		a, c	15
3	40882.08	1.230	a, c	17	3	47896.90		a, c	15
2	41211.02	1.444	a, c	18	3	47938.44	1.33:	a, d	19

TABLE 4. Even Levels of Hf I—Continued

J	Level	Obs. g	Notes	No. Comb.	J	Level	Obs. g	Notes	No. Comb.
2	47955.19		a, c	24	2	49438.81		a	10
4	48022.20		a, c	15	1	49446.83		a	8
3	48049.44		a, d	16	5	49540.65		a, c	11
1	48129.58		a, c	11	4	49623.42		a	18
2	48179.12		a	14	3	49660.56		a	26
4	48220.74		a, c	17	3	49791.86		a	24
1	48309.88		a, d	8	3	49999.13	1. 398	a	11
3	48319.12		a	23	2	50193.24		a	17
4	48356.92		a, c	14	5	50279.54		a	9
2	48407.25		a, c	23	4	50393.21		a	14
2	48459.08		a, d	14	3	50680.42	1. 146:	a	10
2	48552.34		a	13	1	50828.57:		a	8
2	48594.81		a	21	6	50888.76:		b, d	3
3	48598.99	0. 505:	a	18	2	50891.34		a	9
2	48708.44	1. 857	a, e	24	1	51091.22		a	7
3	48746.51		a, d	16	4	51201.45		a	11
3	48809.77		a, c	14	4	51390.77		b	10
3	48869.45		a, c	23	3	51395.73		a	20
2	48906.42		a, g	13	5	51408.67		a	16
1	48982.17:		a, d	9	2	51508.36		a	10
2	48991.42		a, c	26	3	51556.21		b	12
4	49005.36		a, d	20	4	51640.33		a	12
5	49178.34:		b	4	2	51771.56		a	10
5	49180.66		a, c	9	2	51782.92		a	8
3	49347.30	1. 304	a, e	20	3	51847.43		a	11
2	49403.97		a	14	5	51929.94		a	10

TABLE 5. Odd Levels of Hf I

J	Level	Obs. g	Notes	No. Comb.	J	Level	Obs. g	Notes	No. Comb.
2	10508.88	0. 805	a, c	70	6	25462.09	1. 38:	a, c	4
1	14017.81	0. 542	a, c	57	2	25634.20	1. 418	a, c	52
2	14435.12	0. 903	a, c	72	5	26202.53	1. 357	a, c	22
3	14541.66	1. 085	a, c	68	3	26305.78	1. 396	a, c	57
2	16163.35	1. 172	a, c	77	1	26463.93	0. 996	a, c	35
2	18011.04	0. 394	a, c	48	2	27149.64	0. 993	a, c	50
1	18143.39	1. 428	a, c	46	0	27231.74		a, c	10
4	18224.97	1. 246	a, c	30	4	27516.40	1. 474	a, c	42
0	18270.12	0. 000	a, c	11	1	27533.74	1. 264	a, g	31
3	18381.50	1. 287	a, c	68	3	27654.33	1. 157	a, c	49
3	19292.68	0. 952	a, c	69	1	28047.91	1. 930	a, c	26
2	19791.29	1. 414	a, c	56	2	28267.40	1. 139	a, c	45
4	20960.10	1. 157	a, c	32	0	28526.20	0. 000	a, c	6
1	21738.70	0. 030	a, c	40	3	28583.69	0. 940	a, c	51
2	22450.54	1. 011	a, c	58	1	28586.39:		b, d	2
5	22901.36	1. 276	a, c	19	1	28790.24	0. 966	a, c	24
3	23448.60	1. 204	a, c	59	4	29246.65	1. 071	a, c	35
3	23644.74	1. 074	a, c	56	2	29401.45	1. 748	a, c	41
4	24785.24	1. 330	a, c	35	2	29752.85	1. 498	a, c	40
0	24966.78	0. 000	a, c	10	3	29996.82	1. 232	a, c	49
1	25194.48	1. 447	a, c	31	4	30733.23	1. 277	a, c	32
					5	30977.00	1. 213	a, c	22

TABLE 5. *Odd Levels of Hf I—Continued*

J	Level	Obs. g	Notes	No. Comb.	J	Level	Obs. g	Notes	No. Comb.
3	31342.50	1.387	a, c	35	2	43517.82	0.997	a, d	13
2	31610.80	1.004	a, c	35	1	43786.59	0.170	a, c	9
4	31943.31	1.401	a, c	35	4	43794.60	1.038	a, d	8
2	31943.82	1.594	a, c	31	1	43844.62	1.363	a	12
1	31952.25	2.080	a, c	20	3	44049.25	1.024	a, d	9
3	32533.32	0.951	a, c	40	1	44257.57	1.216:	a	9
2	33121.48	1.342	a, c	27	3	44463.51	1.292	a, d	9
1	33137.89	0.772	a, c	22	2	44503.72	1.014	a, c	6
3	33139.13	1.441	a, c	42	5	44537.49	1.247	a, c	6
2	33538.14	0.821	a, c	26	3	45112.22		a, c	12
3	33949.28	1.088	a, c	28	6	45124.39:	1.326	a, c	1
4	33994.71	1.031	a, c	23	2	45138.88		a	11
2	33994.86	0.934	a, f	24	4	45321.49		b, d	9
1	34596.47	0.970	a, c	16	3	45455.14		a	10
4	34805.90	0.992	a, e	19	3	45522.34		a	7
3	34877.04	0.955	a, c	31	0	45533.45		b, d	3
2	34947.95	1.164	a, c	24	1	45799.49	1.426	a, d	8
1	35284.32	1.061	a, g	15	2	45848.38		a	10
3	35453.82	1.002	a, f	32	2	46170.11		a, d	9
5	35993.73	1.130	a, c	17	3	46218.21		a	8
4	36075.04	1.063	a, c	22	4	46289.68	1.269	a, c	8
3	36237.34	1.047	a, c	20	1	46460.74		b	8
5	36419.26	1.118	a, c	14	3	46775.95		a, d	7
3	36609.86	1.256	a, c	24	2	46981.19		a	7
2	36772.85	1.153	a, c	18	3	47070.67		a, d	9
4	36850.04	1.062	a, e	20	1	47092.01		a	8
1	36949.27	0.531	a, f	9	2	47345.10		a	12
4	37269.84	1.165	a, g	21	5	47366.86	1.310	b, d	7
6	37301.59	1.15:	a, d	6	3	47590.11	1.346	a	10
0	37843.71	0.000	b, d	2	1	47640.24		b	7
1	38151.72	1.433	a, c	8	1	47876.61		b, d	7
2	38325.46	1.153	a, c	14	3	47884.71		a	11
3	38407.80	1.296	a, c	14	3	47931.85	0.828	b, d	4
5	38845.45	1.208	a, c	12	2	47937.90		b	8
4	38987.85	1.142	a, e	19	4	48047.90		a, d	10
3	39193.92	1.283	a, c	19	3	48081.48		a	13
2	39435.19	1.355	a, c	10	4	48236.17		a, d	10
1	39704.40	0.618	a, d	10	1	48259.17:		a, d	9
2	40194.45	0.511	a, f	14	3	48647.51		a, d	8
2	40267.32	1.082	a, c	15	2	48951.98		a, d	14
1	40704.12	1.153	a, d	8	0	48985.40		a, d	4
3	40767.43	1.215	a, c	11	1	49204.11		a, d	7
2	40957.53:	0.78:	a, c	8	4	49268.25		a, d	10
0	41133.80	0.000	b, d	2	5	49389.44		a, d	6
4	41175.36	1.203	a, d	13	2	50084.58		a, d	7
1	41193.94	1.319	a, d	11	3	50354.52		a, d	9
3	41422.44	0.934	a, c	11	2	50364.65		b, d	8
2	41768.67	0.926	a, d	12	3	50583.62		a	7
3	41824.58	1.131:	a, d	19	3	50857.91		a, d	7
1	42036.40	1.229	a, f	11	2	50879.35:		b, d	4
2	42075.81	1.232	a, d	10	6	51641.85	1.084:	b, d	4
5	42166.60:	b, d		2	3	51739.26:		b, d	4
2	42302.11	0.861	a, d	16	4	51968.59		a, d	8
3	42395.66	1.062	a, c	14	4	52581.23:		a, d	8
4	42453.70	1.034	a, c	7	4	53063.82		a	5
1	42485.49	0.859	a, d	9	0	53853.61		a	3
4	42871.00	1.144	a, c	9	2	57622.92		b	6
3	43104.70	1.078	a, d	12	2	58115.27		b	8

TABLE 6. Zeeman Effect Hf I; Sums of Observed and Landé g-values for Even Terms

Electrons	J	5		4		3		2		1		0	
		Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé
$5d^2 6s^2$	a^3F			1.240	1.250	1.083	0.696	0.667	1.496	1.500	0.000	0.000	0/0
	a^3P			1.007	1.000		1.300	1.500					
	a^1G						1.164	1.000					
	a^1D												
	Sum			2.247	2.250	1.082	1.083	3.160	3.167	1.496	1.500	0.000	0/0
$5d^3 6s$	a^5F	1.383	1.400	1.341	1.350	1.248	1.250	1.007	1.000	0.010	0.000		
	b^3F				1.144	1.083		0.902	0.667				
	a^5P						1.734	1.833	2.40	2.500			
	b^3P						1.393	1.500	1.222	1.500			
	a^3G	1.142	1.200	1.028	1.050	0.802:	0.750						
	c^3F			1.150	1.250	1.085	1.083	0.889	0.667				
	a^3D					1.223	1.333						
	b^1D							1.371	1.500				
	c^3P							1.007	1.000				
	a^1P												
$5d^4$	b^3D							1.110	1.167	1.167	1.000	0.500	
	c^1D							1.085	1.000				
	Sum	2.525	2.600	3.519	3.650	6.767	6.832	10.498	10.334	5.304	5.500		
	a^5D			1.281	1.500	1.338	1.500	1.444	1.500	1.511	1.500		
	Sum—Low Even Terms	2.525	2.600	7.047	7.400	9.187	9.415	15.102	15.001	8.311	8.500	0.000	0/0
$5d^2 6s 7s$	b^5F	1.400	1.400	1.353	1.350	1.230	1.250	1.009	1.000	0.216	0.000		
	d^3F			1.248	1.250	1.196	1.083	0.826	0.667				
	Sum—High Even Terms		1.400	1.400	2.601	2.600	2.426	2.333	1.835	1.667	0.216	0.000	

TABLE 7. Zeeman Effect Hfr: Sums of Observed and Landé g-values for Odd Terms

Electrons	J	6				5				4				3				2				1					
		Terms		Obs.	Landé																						
		z	y																								
5d 6s ² 6p		z 3F ^o				1.246	1.250	1.085	1.083	0.903	0.667	0.542	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500		
		z 3D ^o						1.287	1.333	1.172	1.167	1.428	1.428	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	
		z 3P ^o								1.414																	
		z 1F ^o								1.074	1.000	0.805	1.000														
		z 1D ^o																									
		z 1P ^o																									
		Sum						1.246	1.250	3.446	3.416	4.294	4.334														
5d ² 6s 6p		z 5G ^o	1.38:	1.333	1.276	1.267	1.157	1.150	0.952	0.917	0.394	0.333															
		z 5F ^o		1.357	1.400	1.330	1.350	1.204	1.250	1.011	1.000	0.030	0.000														
		z 5D ^o		1.213	1.200	1.071	1.050	0.940	0.750	1.418	1.500	1.447	1.500														
		z 3G ^o				1.277	1.250	1.157	1.083	0.993	0.667																
		y 3F ^o																									
		y 3D ^o																									
		y 5D ^o																									
		z 5P ^o																									
		z 5S ^o																									
		x 3D ^o																									
		y 3P ^o																									
		z 3S ^o																									
		y 3G ^o																									
		x 3F ^o																									
		w 3D ^o																									
		z 1G ^o																									
		y 1F ^o																									
		y 1D ^o																									
		y 3F ^o																									
		v 3D ^o																									
		x 3P ^o																									
		x 1F ^o																									
		x 1D ^o																									
		y 1P ^o																									

TABLE 7. Zeeman Effect Hf I: Sums of Observed and Landé g-values for Odd Terms—Continued

Electrons	J	6				5				4				3				2				1			
		Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé	Obs.	Landé		
5d ² 6s 6p Cont.																									
	<i>u</i> ³ D°																								
	<i>w</i> ³ P°																								
	<i>w</i> ¹ D°																								
	<i>x</i> ¹ P°																								
	<i>z</i> ³ H°	1. 15:	1. 167	1. 118	1. 033	0. 992	0. 800																		
	<i>x</i> ³ G°			1. 208	1. 200	1. 062	1. 050																		
	<i>w</i> ³ F°					1. 165	1. 250	1. 002	1. 083																
	<i>y</i> ¹ G°					1. 034	1. 000			1. 062	1. 000														
	<i>w</i> ¹ F°																								
	Sum	2. 53:	2. 500	7. 302	7. 300	15. 199	15. 200	21. 942	22. 331	23. 469	24. 169	15. 574	15. 000	0. 000	0. 000										
Sum—Odd Terms		2. 53:	2. 500	7. 302	7. 300	16. 445	16. 450	25. 388	25. 747	27. 763	28. 503	18. 540	18. 000	0. 000	0. 000										

TABLE 8. The Strongest Unclassified Lines of Hf I

Wavelength Å Air	Intensity		Wavelength Å Air	Intensity	
	Tube	Spark		Tube	Spark
8143.62	60	7	3285.644	30	
7612.60	50	8	3276.431	30	1
4708.053	30	4Z	3239.393	80	8Z
4041.768	40	2	3230.058	100	10Z
3902.937	90	8Z	3135.562	30	2
3545.937	50	2	3087.196	60	6
3528.217	30		3076.885	30	1
3522.223	30		3067.614	60	10
3491.587	60	1	3037.28	30	0
3465.120	30	1	2718.445	30	4
3464.720	50	2	2699.632	70	10Z
3448.284	100	8Z	2671.721	40	1
3392.450	30	1	2630.907	100	3
3303.871	30	2	2611.340	30	1
3299.662	40		2458.653	30	
			2456.061	30	

Appendix A. Zeeman Data, Hf I

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st g	2nd g	Zeeman Components	
	Tube	Spark						Strong p	Strong n
8711.20	600	100	15673 ₃ —27149 ₆	2	0.25	1.25	1.00	0	1.75
8640.04	2500	500	6572 ₁ —18143 ₁	3	0.07	1.50	1.43	0.07	(1.43, 1.50)
8546.43	2500	500	6572 ₁ —18270 ₆	7	1.50	1.50	0.00	0	1.50
8460.00	500	120	16766 ₄ —28583 ₃	2	0.395	1.355	0.960	0	2.539
8344.25	400	80	15673 ₃ —27654 ₃	3	0.09	1.25	1.16	0.28	(1.16, 1.25)
8276.94	1000	200	2356 ₃ —14435 ₂	2	0.19	1.08	0.89	0	1.46
8204.57	2000	500	2356 ₃ —14541 ₃	7	0.00	(1.08)	1.08	0	1.08
8173.90	300	70	20908 ₂ —33139 ₃	1	0.298	1.739	1.441	0	0.845
8080.26	500	100	5638 ₂ —18011 ₂	3	0.774	1.164	0.390	1.545	(0.388, 1.165)
7994.76	5000	800	5638 ₂ —18143 ₁	1	0.261	1.167	1.428	0	0.906
7938.06	500	100	15673 ₃ —28267 ₂	2	0.100	1.258	1.158	0	1.458
7920.75	2000	400	5521 ₀ —18143 ₁	7	1.43	(0.000)	1.43	0	1.43
7845.37	4000	800	5638 ₂ —18381 ₂	2	0.112	1.182	1.294	0	1.518
7814.57	400	80	14740 ₂ —27533 ₁	1	0.264	1.005	1.269	0	0.741
7790.90	500	100	17901 ₅ —30733 ₄	2	0.110	1.405	1.295	0	1.845
7743.57	150	20	15673 ₃ —28583 ₃	3	0.30	(1.25)	0.95	0.909	?
7740.17	2000	400	10532 ₄ —23448 ₃	1	0.190	1.012	1.202	0	0.442
7645.655	400	80	17901 ₅ —30977 ₅	3	0.175	1.388	(1.213)	0.877	?
7624.387	5000	1000	10532 ₄ —23644 ₃	1	0.06	(1.007)	1.07	0.27w	0.81+
7592.977	150	30	23252 ₄ —36419 ₅	2?	0.094	(1.027)	1.121?	0	?

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st g	2nd g	Zeeman Components	
	Tube	Spark						Strong p	Strong n
7577.02	300	40	18381 ₂ –31575 ₄	1	0.137	(1.287)	1.150	0	?
7564.24	200	40	24085 ₅ –37301 ₆	7	0.01	(1.14)	1.15	0	1.20
7562.93	1500	300	6572 ₁ –19791 ₂	1	0.091	1.504	1.413	0	1.322
7556.37	200	40	16766 ₄ –29996 ₃	2	0.116	1.348	(1.232)	0	?
7463.905	200	40	23644 ₃ –37038 ₂	7	0.003	(1.074)	1.077	0	1.065
7437.600	500	100	14092 ₁ –27533 ₁	3	1.244	0.000	1.244	1.244	1.244
7423.628	120	20	8983 ₂ –22450 ₂	3	0.30	(1.300)	1.00	0.59	?
7390.729	400	60	14740 ₂ –28267 ₂	3	0.136	1.008	1.144	0.272	1.008, 1.144
7321.79	150	30	5638 ₂ –19292 ₃	1	0.211	(1.164)	0.953	0	?
7320.06	1000	200	4567 ₄ –18224 ₄	7	0.00	(1.240)	1.24	0	1.24
7262.587	80	10	14435 ₂ –28200 ₂	3	0.49	(0.903)	1.39	0.97	?
7240.87	5000	600	2356 ₃ –16163 ₂	1	0.08	(1.082)	1.16	0w	0.92+
7237.101	8000	1000	4567 ₄ –18381 ₃	1	0.04	(1.240)	1.28	w	1.12
7131.82	7000	1000	0 ₂ –14017 ₁	2	0.145	0.696	0.551	0	0.841
7119.520	700	100	17901 ₅ –31943 ₄	1	0.01	1.39	(1.401)	w	1.33
7094.412	100	15	25194 ₁ –39286 ₁	3?	1.23	(1.447)	0.22	1.23	?
7063.852	3000	400	5638 ₂ –19791 ₂	3	0.244	1.166	1.410	0.486	1.165, 1.411
6979.61	100	20	15673 ₃ –29996 ₃		0.02	1.25	(1.23)	0.06	1.24h
6926.21	70	10	14092 ₁ –28526 ₆	0		0.00	0.00	Unaffected	Unaffected
6911.40	300	80	8983 ₂ –23448 ₃	1	0.100	1.291	1.191	0	0.991
6874.89	40	5	0 ₂ –14541 ₃	2	0.384	(0.696)	1.080	0	?
6858.76	200	40	16766 ₄ –31342 ₃	1	0.035	1.352	(1.387)	w	1.245
6857.03	20	3	24966 ₀ –39546 ₁	7	0.83	(0.00)	0.83	0	0.83
6850.06	60	8	25194 ₁ –39788 ₂	1	0.441	1.457	1.016	0	0.575
6826.55	100	10	23644 ₃ –38289 ₂	7	0.01	(1.074)	1.08	0	1.06
6818.95	2000	300	8983 ₂ –23644 ₃	1	0.222	1.304	1.082	0	0.638
6789.28	1000	100	4567 ₄ –19292 ₃	2	0.288	1.249	0.961	0	2.114
6773.06	30	3	24085 ₅ –38845 ₃	3	0.12	(1.14)	1.26	0.94	1.200
6769.924	40	5	27516 ₄ –42283 ₄	3	0.132	(1.474)	1.342	0.542	?
6744.00	7		24966 ₀ –39790 ₁	7	0.58	0.00	0.58	0	0.58
6716.014	30	3	22450 ₂ –37336 ₁	2	0.528	1.009	0.481	0	1.536
6713.48	200	20	16163 ₂ –31054 ₃	1	0.083	(1.173)	1.090	w	0.925
6708.33	20	3	24085 ₅ –38987 ₄	7	0.00	1.14	(1.137)	0	1.17
6693.491	15	1	25194 ₁ –40130 ₂	1	0.227	1.431	1.204	0	0.977
6684.50	30	2	16163 ₂ –31119 ₂	3	0.286	1.170	0.884	0.578	0.886, 1.168
6671.28	20	2	25281 ₃ –40267 ₂	2	0.065	1.147	(1.082)	w	1.276
6669.34	15	2	28527 ₁ –43517 ₂	1	0.225	1.222	0.997	0	0.772
6659.42	40	4	14740 ₂ –29752 ₂	3	0.499	1.002	1.501	0.999	1.002, 1.501
6587.23	150	15	16766 ₄ –31943 ₄	3	0.06	1.34	1.40	0.244	1.37
6556.48	70	6	25634 ₂ –40882 ₃	1	0.180	1.403	1.223	0	0.862
6552.91	20	2	14740 ₂ –29996 ₃	2	0.218	1.021	1.239	0	1.673
6536.56	15		28267 ₂ –43561 ₁	1	0.322	1.133	1.455	0	0.811
6523.92	30	2	19791 ₃ –35115 ₂	3	0.291	1.417	1.126	0.583	1.126, 1.417
6456.956	50	6	23644 ₃ –39127 ₃	3	0.239	1.069	1.308	0.717	1.069, 1.308
6429.44	10		30733 ₁ –46282 ₄	3	0.03	1.28	1.25	0.12	1.26

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st g	2nd g	Zeeman Components	
	Tube	Spark						Strong p	Strong n
6418.02	10		25634 ₃ —41211 ₂	3	0.024	1.43	1.45	0.047	1.433
6409.50	70	7	21738 ₁ —37336 ₁					Unaffected	Unaffected
6388.914	20	2	26463 ₁ —42111 ₁	3	0.240	0.996	0.756	0.240	0.756, 0.996
6386.229	300	40	2356 ₃ —18011 ₂	2	0.689	1.078	0.389	0	2.456
6380.196	80	7	15673 ₃ —31342 ₃	3	0.136	1.244	1.380	0.408	1.244, 1.380
6376.19	20	2	23448 ₃ —39127 ₃	3	0.12	1.22	1.34	0.35	1.28
6338.096	80	9	10532 ₄ —26035 ₃	1	0.392	0.983	1.375	0	-0.193
6318.313	30	3	19292 ₃ —35115 ₂	1	0.164	0.938	1.102	0	0.610
6311.844	50	7	22450 ₂ —38289 ₂	3	0.08	1.02	1.10	0.16	1.06
6299.52	50	6	26305 ₃ —42175 ₄	1	0.17	(1.396)	1.23	0.41w	0.60
6277.197	10	1		7				0	1.108
6271.355	15	2	23252 ₄ —39193 ₃	7	0.323	0.960	(1.283)	0.968	?
6258.79	40	4	26202 ₃ —42175 ₄	2	0.062	(1.357)	1.295	0w	1.604
6256.97	70	9	26305 ₃ —42283 ₄	1	0.041	(1.396)	1.355	0w	1.232
6241.81	10	1	25194 ₁ —41211 ₂	7	0.018	(1.449)	1.431	0	1.415
6238.59	100	10	2356 ₃ —18381 ₃	3	0.201	1.089	1.290	0.605	1.089, 1.290
6216.800	80	10	26202 ₃ —42283 ₄	7	0.019	(1.357)	1.338	0	1.432
6212.00	20	2	17901 ₅ —33994 ₁	2	0.360	1.378	1.018	0	2.818
6210.680	150	20	24785 ₁ —40882 ₃	2	0.098	1.328	(1.230)	0.263w	1.620
6209.43	40	4	5638 ₂ —21738 ₁	2	1.134	1.157	0.023	0	2.291
6198.460	20	2	14017 ₁ —30146 ₂	2	0.817	0.545	1.362	0	2.179
6192.475	50	5	23644 ₃ —39788 ₂	2	0.05	(1.074)	1.02	0w	1.18
6185.128	400	40	0 ₂ —16163 ₂	3	0.475	0.692	1.167	0.949	0.692, 1.167
6168.66	20	2	10508 ₂ —26175 ₃	2	0.449	0.774	1.223	0	2.122
6152.952	10	1	29401 ₂ —45649 ₃	1	0.575	1.725	1.150	0	0.575
6144.392	30	2	15673 ₃ —31943 ₂	1	0.354	1.236	1.590	0	0.528
6118.16	40	6	23448 ₃ —39788 ₂	2	0.192	1.193	1.001	0	1.577
6104.58	20	3	23327 ₂ —39074 ₁	2	0.283	0.902	0.619	0	1.185
6098.68	200	30	4567 ₄ —20960 ₁	3	0.070	1.239	1.169	0.278	1.204
6091.37	20	2	27149 ₂ —43561 ₁	1	0.474	0.992	1.466	0	0.518
6054.166	80	6	14541 ₃ —31054 ₃	7	0.00	1.08	1.08	0	1.08
6040.37	15	1	21738 ₁ —38289 ₂	2	1.056	0.035	1.091	0	2.147
6021.77	20	2	14740 ₂ —31342 ₃	2	0.376	1.041	1.417	0	2.169
6016.78	100	20	27516 ₁ —44132 ₅	1	0.074	(1.474)	1.400	0w	1.105
6004.18	30	2	8983 ₂ —25634 ₂	3	0.12	1.30	1.42	0.24	1.36±
5994.58	10		22450 ₂ —39127 ₃	2	0.292	1.063	1.355	0	1.937
5992.97	50	6	23448 ₃ —40130 ₂	7	0.009	(1.204)	1.213	0	1.186
5986.62	20	2	29401 ₂ —46100 ₁	1	0.368	1.749	2.117	0	1.381
5978.67	150	20	18270 ₆ —34991 ₁	7	0.50	0.00	0.50	0	0.50
5974.728	80	8	19791 ₃ —36523 ₃	1	0.140	1.392	1.252	0w	0.972
5974.294	200	30	18381 ₃ —35115 ₂	2	0.171	1.277	1.106	0	1.618
5938.142	15	2	22450 ₂ —39286 ₁	2	0.790	1.019	0.229	0	1.809
5933.70	150	20	18143 ₁ —34991 ₁	3	0.927	1.436	0.509	0.927	0.509, 1.436
5926.48	40	5	23644 ₃ —40513 ₂	7	0.008	(1.074)	1.082	0	1.057
5902.95	500	70	2356 ₃ —19292 ₃	3	0.135	1.073	0.938	0.408	0.938, 1.073
5896.63	50	4	24785 ₁ —41739 ₃	7	0.005	(1.330)	1.335	0	1.315

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st g	2nd g	Zeeman Components	
	Tube	Spark						Strong p	Strong n
5890.46	200	30	18143 \downarrow —35115 $_2$	1	0.312	1.425	1.113	0	0.800
5887.43	20	2	18011 \downarrow —34991 $_1$	1	0.085	(0.394)	0.479	0	0.309
§5886.31	30	2	10532 \downarrow —27516 \downarrow	3				1.386	?
5883.650	70	10	23644 \downarrow —40636 $_2$	7	0.012	(1.074)	1.062	0	1.098
5860.42	4		20784 \downarrow —37843 \downarrow	7	2.40	2.40	0.00	0	2.40
5858.349	30	3	23448 \downarrow —40513 $_2$	2	0.114	(1.204)	1.090	0	1.433
5849.688	60	8	24085 \downarrow —41175 \downarrow	1	0.059	1.144	(1.203)	0w	0.906
5847.768	80	8	22450 \downarrow —39546 $_1$	2	0.193	1.018	0.825	0	1.211
5845.866	100	10	14017 \downarrow —31119 $_2$	2	0.332	0.559	0.891	0	1.223
5838.896	40	4	10532 \downarrow —27654 \downarrow	1	0.150	1.031	1.181	0	0.581
5817.475	80	6	14435 \downarrow —31619 $_2$	3	0.11	0.90	1.01	0.22	0.96
5802.88	40	3	16766 \downarrow —33994 \downarrow	3	0.301	1.356	1.055	1.247	1.055, 1.356
5799.760	50	5	23644 \downarrow —40882 $_3$	3	0.15	1.15	1.30	0.49	1.23
5796.329	30	2	19791 \downarrow —37038 $_2$	3?	0.335	1.428?	1.093?	0.641	1.428?, 1.093?
5765.96	30	4	22450 \downarrow —39788 $_2$	7	0.02	(1.011)	1.03	0	1.02
5765.37	40	4	22450 \downarrow —39790 $_1$	2	0.412	1.013	0.601	0	1.425
5758.96	10		29752 \downarrow —47112 $_3$	7	0.02	(1.498)	1.48	0	1.44
5756.83	10		31342 \downarrow —48708 $_2$	7	0.470	(1.387)	1.857	0	1.447
5734.514	50	6	23448 \downarrow —40882 $_3$	3	0.03	1.17?	1.20?	0.08	1.18
5729.683	20	2	15673 \downarrow —33121 \downarrow	1	0.07	(1.248)	1.32	0w	1.12
5719.175	600	100	8983 $_2$ —26463 \downarrow	2	0.307	1.304	0.997	0	1.611
5713.267	100	10	24785 \downarrow —42283 $_4$	7	0.00	(1.330)	1.33	0	1.33
5702.10	20	2	26305 \downarrow —43838 $_4$	1	0.096	(1.396)	1.300	0w	1.012
5697.25	15	2	21738 \downarrow —39286 $_1$	3	0.176	0.008	0.184	0.175	0.008, 0.184
5683.738	6		25281 \downarrow —42871 \downarrow	7	0.00	1.14	(1.144)	0	1.14
5679.553	30		14017 \downarrow —31619 $_2$	2	0.476	0.530	1.006	0	1.482
5668.716	20	2	26202 \downarrow —43838 $_4$	2	0.072	(1.357)	1.285	0	1.643
5662.982	20	2	23644 \downarrow —41298 $_2$	2	0.247	(1.074)	0.827	0	1.62?
5662.078	40	4	14435 \downarrow —32091 $_1$	1	0.271	0.896	1.167	0	0.624
5654.645	80	9	22450 \downarrow —40130 $_2$	3	0.206	1.006	1.212	0.410	1.006, 1.212
5650.811	50	6	10508 \downarrow —28200 $_2$	3	0.581	0.812	1.393	1.162	0.810, 1.396
5644.67	30	3	29401 \downarrow —47112 $_3$	1	0.285	1.763	1.478	0	0.908
5633.450	20	2	19292 \downarrow —37038 $_2$	1	0.14	(0.952)	1.09	0w	0.68
5628.293	40	4	23448 \downarrow —41211 $_2$	1	0.250	1.200	1.450	0	0.703
§5614.004	80	10	21738 \downarrow —39546 $_1$?	0.776	0.039	(0.815)	0.776	1.722?
5613.259	400	70	5638 $_2$ —23448 \downarrow	7	0.03	(1.164)	1.19	0	1.23
5606.613	20	2	23644 \downarrow —41475 $_3$	3	0.214	(1.074)	1.288	0.643	
5600.762	60	6	23448 \downarrow —41298 $_2$	2	0.368	1.198	0.830	0	1.934
5578.008	15	2	23252 \downarrow —41175 \downarrow	3	0.210	0.993	(1.203)	0.839	?
5575.857	200	30	26202 \downarrow —44132 $_5$	3	0.03	1.35	1.38	0.12	1.37
5552.128	1000	100	5638 $_2$ —23644 \downarrow	1	0.08	(1.164)	1.08	0w	0.91
5550.61	1000	100	0 $_2$ —18011 \downarrow	3	0.290	0.690	0.400	0.586	0.400, 0.690
5541.920	15	2	16766 \downarrow —34805 $_4$	3	0.345	1.322	0.975	1.368	0.975, 1.322
5534.638	8	1	22450 \downarrow —40513 $_2$	3	0.08	1.02	1.10	0.16	1.06
5530.268	30	2	22880 $_3$ —40957 \downarrow	7	0.02	(0.802?)	0.78	0	0.84

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st <i>g</i>	2nd <i>g</i>	Zeeman Components	
	Tube	Spark						Strong <i>p</i>	Strong <i>n</i>
5522.554	20	2		7				0	1.07
5520.01	10	1		1				0w	0.90+
5510.436	40	7	18381 ₃ —36523 ₃	7	0.026	(1.287)	1.261	0	1.274
5510.116	60	6	0 ₂ —18143 ₁	1	0.749	(0.696)	1.445	0	0
§5497.301	50	5	22450 ₂ —40636 _{2?}	1	0.18			0	1.03
5467.32	10	1	20908 ₂ —39193 ₃	1	0.446	1.732	1.286	0	0.394
5465.73	20	2	23448 ₃ —41739 ₃	3	0.13	1.19	1.32	0.40	1.25±
5463.31	150	20	18224 ₄ —36523 ₃	7	0.03	1.25	(1.266)	0	1.21
5452.92	300	30	4567 ₄ —22901 ₃	7	0.015	(1.240)	1.255	0	1.317
5438.75	100	10	0 ₂ —18381 ₃	2	0.582	0.714	1.296	0	2.460
5435.781	30	4	21738 ₁ —40130 ₂	7				0	1.48?
5423.981	60	9	22450 ₂ —40882 ₃	2	0.227	1.010	1.237	0	1.691
5404.457	50	7	19791 ₂ —38289 ₂	3	0.325	1.407	1.082	0.645	1.081, 1.407
5398.655	10	1	17901 ₅ —36419 ₃	3	0.269	(1.383)	1.114	1.346	?
5394.896	20	3	23644 ₃ —42175 ₄	2	0.220	1.064	1.284	0	1.944
5389.336	100	20	8983 ₂ —27533 ₁	7	0.01	(1.300)	1.29	0	1.31
5383.04	40	4	23252 ₄ —41824 ₃	1	0.092	1.039?	(1.131)	0w	0.754
5376.302	10	1	24966 ₀ —43561 ₁	7	1.480	(0.000)	1.480	0	1.480
5373.863	300	50	2356 ₃ —20960 ₄	2	0.071	(1.082)	1.153	0w	1.367
§5371.80	2	4		1?	0.55			0	1.10, 1.65
5368.52	20	2	6572 ₁ —25194 ₁	7	0.06	(1.496)	1.44	0	1.47
5358.338	40	6	18381 ₃ —37038 ₂	2	0.200	1.279	1.079	0	1.679
5354.724	200	40	25462 ₆ —44132 ₅	1	0.02	1.38?	(1.400)	0	1.04+
5315.928	15	1	26463 ₁ —45270 ₁	3	0.390	0.986	1.376	0.391	0.986, 1.376
5309.681	100	15	16163 ₂ —34991 ₁	2	0.663	1.180	0.517	0	1.843
5307.812	60	8	23448 ₃ —42283 ₄	2	0.142	1.256	1.398	0	1.824
5304.178	40	4	22450 ₂ —41298 ₂	3	0.185	0.968	0.783	0.375	0.783, 0.965
5294.870	300	30	4567 ₄ —23448 ₃	7	0.092	(1.240)	1.332	0	1.293
5292.783	30	3	22880 ₃ —41768 ₂	1	0.124	0.802	(0.926)	0	0.555
5290.812	20	2	18143 ₁ —37038 ₂	1	0.303	1.372	1.069	0	0.766
5286.098	70	7	23448 ₃ —42360 ₃	3	0.050	1.195	1.145	0.149	1.170
5275.04	150	20	16163 ₂ —35115 ₂	3	0.058	1.169	1.111	0.117	1.140
5258.736	40	5	26463 ₁ —45474 ₁	3	0.414	1.006	1.420	0.414	1.006, 1.420
5255.464	15		28583 ₃ —47606 ₄	7	0.03	(0.940)	0.97	0	1.07h
5254.48	20	3	23644 ₃ —42670 ₄	2	0.16	(1.074)	1.23	0w	1.69-
5247.031	40	3	24785 ₃ —43838 ₄	7	0.06	(1.330)	1.27	0	1.30
5244.67	50	4	6572 ₁ —25634 ₂	7	0.057	(1.496)	1.439	0	1.381
5243.984	250	30	8983 ₂ —28047 ₁	1	0.640	1.278	1.918	0	0.638
5222.43	10	1	23252 ₄ —42395 ₃	7	0.034	1.028	(1.062)	0	0.924
5200.866	20	2	23448 ₃ —42670 ₄	1	0.028	(1.204)	1.232	0	1.315
5199.545	10	1	16766 ₄ —35993 ₃	1	0.222	(1.341)	1.119	0	0.230
5186.825	50	10	22901 ₅ —42175 ₄	7	0.015	(1.275)	1.260	0	1.236
5184.295	20	2	8983 ₂ —28267 ₂	3	0.15	1.34	1.19	0.30	1.26
5181.87	300	60	0 ₂ —19292 ₃	2	0.251	0.719	0.970	0	1.472
5173.162	15	2	18011 ₂ —37336 ₁	7	0.070	(0.394)	0.464?	0	0.324

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st <i>g</i>	2nd <i>g</i>	Zeeman Components	
	Tube	Spark						Strong <i>p</i>	Strong <i>n</i>
5170.173	100	20	19791 ₂ —39127 ₃	1	0.088	(1.414)	1.326	0w	1.150
5167.376	30	4	24785 ₄ —44132 ₅	2	0.06	1.34	(1.400)	0w	1.62
5166.390	20	2	29996 ₃ —49347 ₃	3	0.053	1.251	1.304	0.158	1.278
5157.95	200	20	22901 ₅ —42283 ₄	1	0.06	1.29	(1.353)	0iv	1.02
§5153.122	40	4	17901 ₅ —37301 ₆	1	0.205	1.320	1.115	0	0.090
5136.20	30	2	10532 ₄ —29996 ₃	1	0.232	(1.007)	1.239	0	0.310
5112.130	100	10	5638 ₂ —25194 ₁	1	0.280	1.165	1.445	0	0.885
5101.668	40	4	27516 ₄ —47112 ₃	1	0.002	(1.474)	1.476	0	1.468
5100.64	60	4	8983 ₂ —28583 ₃	1	0.345	1.272	0.927	0	0.237
5090.876	15	2	10508 ₂ —30146 ₂	3	0.55	0.82	1.38	1.09	0.82, 1.38
5069.810	20	1	26463 ₁ —46183 ₂	1	0.054	(0.996)	0.942	0	0.887
5051.319	50	3	0 ₂ —19791 ₂	3	0.712	0.706	1.418	1.42	0.706, 1.418
5047.440	300	30	8983 ₂ —28790 ₁	2	0.335	1.309	0.974	0	1.644
5037.74	9		23644 ₃ —43489 ₃	7	0.122?	(1.074)	1.196?	0	1.135
5034.92	30	3	14740 ₂ —34596 ₁	7	0.003	(1.007)	1.004	0	1.010
5025.91	15	1	6572 ₁ —26463 ₁	3	0.506	1.510	1.004	0.504	1.004, 1.510
5023.09	70	5	14092 ₁ —33994 ₂	2	0.923	0.009	0.932	0	1.855
5021.745	40	5	18381 ₃ —38289 ₂	2	0.198	1.288	1.090	0	1.684
5021.13	40	5	22450 ₂ —42360 ₃	2	0.13	(1.011)	1.14	0w	1.39
5018.20	200	20	20960 ₃ —40882 ₃	1	0.070	1.160	(1.230)	0.102	0.952
5000.54	20	2	24785 ₄ —44777 ₄	3	0.080	(1.330)	1.250	0.322	?
4975.26	400	50	2356 ₃ —22450 ₂	7	0.056	(1.082)	1.026	0	1.195
4962.381	50	6	18143 ₁ —38289 ₂	1	0.335	1.408	1.073	0	0.738
4948.951	100	15	10532 ₄ —30733 ₁	3	0.266	1.007	1.273	1.062	1.007, 1.273
4947.336	15	2	14740 ₂ —34947 ₂	3	0.152	1.000	1.152	0.303	1.076
4943.42	15	2		7				0	1.455
§4932.260	7		22450 ₂ —42719 ₂	2	0.184?			0.368	1.264
4915.32	40	6	19791 ₂ —40130 ₂	3	0.205	1.425	1.220	0.410	1.220, 1.425
4910.10	30	2	16163 ₂ —36523 ₃	2	0.097	(1.172)	1.269	0	1.464
4903.06	20	2	23448 ₃ —43838 ₄	2	0.088	(1.204)	1.292	0w	1.555
4896.34	40	4	8983 ₂ —29401 ₂	3	0.460	1.296	1.756	0.962	1.296, 1.756
4889.932	20	2	10532 ₄ —30977 ₅	2	0.19	(1.007)	1.20	0w	1.98
4878.166	20	4		7				0	1.383
4877.587	150	20	19292 ₃ —39788 ₂	7	0.024	(0.952)	0.976	0	0.905
4872.949	50	5	20960 ₄ —41475 ₃	1	0.120	1.146	1.266	0.360w	0.786
4863.282	150	20	14435 ₂ —34991 ₁	2	0.400	0.904	0.504	0	1.304
4859.24	200	30	14541 ₃ —35115 ₂	7	0.02	1.09	(1.110)	0	1.06
4858.42	70	7	6572 ₁ —27149 ₂	1	0.496	1.482	0.986	0	0.490
4837.238	150	20	5638 ₂ —26305 ₃	2	0.228	1.176	1.404	0	1.860
4834.20	80	10	14435 ₂ —35115 ₂	3	0.216	0.903	1.121	0.427	0.903, 1.121
4818.84	100	15	18381 ₃ —39127 ₃	7	0.000	1.299	1.299	0	1.299
4811.146	40	5	20960 ₄ —41739 ₃	1	0.201	(1.157)	1.358	0?	0.565?
4800.50	500	100	5638 ₂ —26463 ₁	2	0.168	1.167	0.999	0	1.335
4795.98	15	2	19791 ₂ —40636 ₂	3	0.346	1.413	1.068	0.697	1.068, 1.413
4782.737	200	50	18224 ₄ —39127 ₃	1	0.050	1.246	1.296	0.15w	1.096

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st <i>g</i>	2nd <i>g</i>	Zeeman Components	
	Tube	Spark						Strong <i>p</i>	Strong <i>n</i>
4777.216	20	2	23448 ₃ —44375 ₂	1	0.140	1.176	1.316	0.280	0.896
4774.904	30	4	22901 ₅ —43838 ₄	7	0.018	1.277	(1.295)	0	1.205
4773.72	150	20	5521 ₀ —26463 ₁	7	1.000	0.000	1.000	0	1.000
4769.372	20	2	6572 ₁ —27533 ₁	3	0.233	(1.496)	1.263	0.233	1.233?, 1.523?
4766.507	100	10	14017 ₁ —34991 ₁	7	0.04	(0.542)	0.50	0w	0.52
4757.611	50	5	8983 ₂ —29996 ₃	7	0.060	(1.300)	1.240	0	1.120
4739.83	40	4	2356 ₃ —23448 ₃	3	0.091	1.091	1.182	0.272	1.136?
4738.574	80	10	14017 ₁ —35115 ₂	2	0.564	0.532	1.096	0	1.660
4721.71	50	5	16163 ₂ —37336 ₁	2	0.695	1.184	0.489	0	1.879
4717.43	30	2	14092 ₁ —35284 ₁	3	1.078	0.000	1.078	1.095	1.061
4708.85	40	5	22901 ₅ —44132 ₅	3	0.140	1.281	1.421	0.699	1.351
4708.053	30	4		7				0	1.182
4699.008	150	30	18011 ₂ —39286 ₁	2	0.174	(0.394)	0.220	0	0.568
4673.176	20	2		0				Unaffected	Unaffected
4670.94	20	2	18143 ₁ —39546 ₁	3	0.624	1.428	0.819	0.640	0.819, 1.428
4669.245	50	7	10532 ₄ —31943 ₁	3	0.401	0.997	1.398	1.600	0.997, 1.398
4655.198	300	50	6572 ₁ —28047 ₁	3	0.443	1.490	1.933	0.440	1.490, 1.933
4650.59	20	2	14740 ₂ —36237 ₃	7	0.02	(1.007)	1.03	0	1.08
4648.35	10		19791 ₂ —41298 ₂	3	0.569	1.407	0.838	1.140	0.838, 1.407
4642.25	30	4	18011 ₂ —39546 ₁	1	0.396	0.396	0.792	0	0
4630.608	40		19292 ₃ —40882 ₃	3	0.282	0.946	1.227	0.858	0.946, 1.227
4620.862	300	30	4567 ₄ —26202 ₂	2	0.124	1.239	1.363	0	1.859
4619.52	20	2	16766 ₄ —38407 ₃	7	0.04	(1.352)	1.31	0	1.48
4608.093	100	10	6572 ₁ —28267 ₂	1	0.351	1.478	1.127	0	0.776
4598.801	300	30	0 ₂ —21738 ₁	2	0.649	0.699	0.050	0	1.348
4597.945	60	6	23644 ₃ —45387 ₄	7	0.053	(1.074)	1.021	0	0.861
4565.95	300	50	5638 ₂ —27533 ₁	1	0.100	1.166	1.266	0	1.066
4562.638	15	1		7				0	1.520
4559.76	20	2	22450 ₂ —44375 ₂	3	0.338	1.013	1.347	0.701	1.013, 1.347
4553.776	80	8	6572 ₁ —28526 ₀	7	1.495	1.495	0.000	0	1.495
4550.16	40	3	24966 ₀ —46937 ₁	7	1.285?	0	1.285?	0	1.285?
4547.87	30	2	14541 ₃ —36523 ₃	3	0.195	(1.085)	1.280	0.584	?
4546.90	10	1	18143 ₁ —40130 ₂	7	0.214	(1.428)	1.214	0	1.00
4544.02	100	10	10532 ₄ —32533 ₃	7	0.029	(1.007)	0.978	0	1.094
4540.934	200	20	5638 ₂ —27654 ₃	7	0.013	(1.164)	1.151	0	1.126
4520.587	30	4	25194 ₁ —47309 ₁	7	0.082	(1.447)	1.529	0	1.488
4518.305	50	5	16163 ₂ —38289 ₂	3	0.085	1.176	1.091	0.171	1.134
4503.095	15		23448 ₃ —45649 ₃	7	0.030	(1.204)	1.174	0	1.189
4499.662	50	5	6572 ₁ —28790 ₁	3	0.540	1.511	0.971	0.540	0.971, 1.511
4492.16	30	2	18381 ₃ —40636 ₂	2	0.186	1.349?	1.163?	0	1.721
4473.042	20	3	23644 ₃ —45994 ₃	7	0.418?	(1.074)	0.656?	0	0.865
4461.181	200	30	5638 ₂ —28047 ₁	1	0.777	1.159	1.936	0	0.382
4457.347	300	40	2356 ₃ —24785 ₂	2	0.244	1.083	1.327	0	2.059
4452.98	80	8	0 ₂ —22450 ₂	3	0.312	0.663	0.972	0.632	0.663, 0.972
4448.086	15		18143 ₁ —40618 ₁	7	0.114?	(1.428)	1.542?	0	1.485

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st g	2nd g	Zeeman Components	
	Tube	Spark						Strong p	Strong n
4438.038	200	30	5521 ₀ —28047 ₁	7	1.92	0	1.92	0	1.92
4418.247	70	9	8983 ₂ —31610 ₂	3	0.306	1.316	1.010	0.611	1.010, 1.316
4417.91	150	20	5638 ₂ —28267 ₂	7	0.14	(1.164)	1.02	0	1.09
4416.19	40	3	23644 ₃ —46282 ₄	2	0.146	(1.074)	1.220	0	1.658
§4379.064	40	3	18381 ₃ —41211 ₂	1	0.163	1.277	1.440	0	0.951
4365.377	60	6	14435 ₂ —37336 ₁	2	0.416	0.920	0.504	0	1.336
4357.000	60	7	5638 ₂ —28583 ₃	1	0.214	1.135	0.921	0	0.493
4356.306	300	40	4567 ₄ —27516 ₁	3	0.235	1.238	1.473	0.940	1.238, 1.473
4353.36	30	5	16163 ₂ —39127 ₃	7	0.133	(1.172)	1.305	0w	1.572
4352.567	60	7	8893 ₂ —31952 ₁	1	0.779	1.302	2.081	0	0.523
4330.282	150	20	4567 ₄ —27654 ₃	2	0.086	1.228	1.142	0	1.486
4318.138	100	10	5638 ₂ —28790 ₁	2	0.194	1.166	0.972	0	1.360
4296.45	50	5	5521 ₀ —28790 ₁	7	0.961	0.000	0.961	0	0.961
4294.78	300	30	2356 ₃ —25634 ₂	1	0.337	1.080	1.417	0	0.406
4263.45	150	15	0 ₂ —23448 ₃	2	0.498	0.698	1.196	0	2.192
4260.98	80	8	10532 ₄ —33994 ₂	3	0.018	1.035	1.017	0.071	1.026
4245.168	40	4	8983 ₂ —32533 ₃	1	0.354	1.304	0.950	0	0.242
4228.074	100	10	0 ₂ —23644 ₃	2	0.377	0.697	1.074	0	1.828
4209.743	100	10	14541 ₃ —38289 ₂	7	0.001	(1.085)	1.086	0	1.082
4201.55	80	10	18381 ₃ —42175 ₄	7	0.002	(1.287)	1.289	0h	1.296
4190.95	50	5	14435 ₂ —38289 ₂	3	0.178	0.903	1.081	0.356	0.903, 1.081
4174.348	1500	150	2356 ₃ —26305 ₃	3	0.316	1.081	1.397	0.948	1.081, 1.397
4145.759	150	15	5638 ₂ —29752 ₂	3	0.334	1.169	1.503	0.669	1.169, 1.503
4118.583	100	8	10532 ₄ —34805 ₄	7	0.006	(1.007)	1.001	0	1.004
4115.88	50	4	18381 ₃ —42670 ₄	1	0.038	(1.287)	1.249	0	1.135
4106.553	200	15	10532 ₄ —34877 ₃	2	0.045	(1.007)	0.962	0.115	1.142
4104.234	150	8	5638 ₂ —29996 ₃	2	0.044?	1.180	1.224	0.087	1.312
4087.942	50	5	16163 ₂ —40618 ₁	1	0.327	1.169	1.496	0	0.841
4083.36	300	30	10508 ₂ —34991 ₁	2	0.303	0.811	0.508	0	1.115
4067.830	100	10	18143 ₃ —42719 ₂	1	0.239	1.424	1.185	0	0.945
4066.21	200	30	14541 ₃ —39127 ₃	3	0.226	1.085	1.311	0.680	1.085, 1.311
4062.84	400	60	10508 ₂ —35115 ₂	3	0.308	0.805	1.113	0.614	0.805, 1.113
4057.439	80	6	18143 ₃ —42782 ₁	3	0.108	1.422	1.530	0.108	1.476
4044.370	80	8	16163 ₂ —40882 ₃	2	0.061?	1.177	1.238	0.122	1.360
4032.266	300	15	2356 ₃ —27149 ₂	2	0.086	1.086	1.000	0	1.254
4011.503	100	4	10532 ₄ —35453 ₃	7	0.003	(1.007)	1.004	0	1.017
3973.477	600	20	2356 ₃ —27516 ₄	2	0.391	1.086	1.477	0	2.650
3951.822	1000	100	2356 ₃ —27654 ₂	3	0.072	1.084	1.156	0.217	1.120
3939.042	100	5	6572 ₁ —31952 ₁	3	0.579	1.500	2.079	0.581	1.500, 2.079
3931.38	700	70	4567 ₄ —29996 ₃	7	0.009	(1.240)	1.231	0	1.266
3927.585	100	15	14740 ₂ —40194 ₂	3	0.487	0.998	0.511	0.970	0.511, 0.998
3926.434	100	8	10532 ₄ —35993 ₂	2	0.123	1.017	1.140	0	1.632
3906.888	80	5	14541 ₃ —40130 ₂	1	0.116	1.078	1.194	0	0.846
3902.937	90	8		7				wh	1.089
3899.937	1000	80	0 ₂ —25634 ₂	3	0.720	0.697	1.417	1.440	0.697, 1.417

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st <i>g</i>	2nd <i>g</i>	Zeeman Components	
	Tube	Spark						Strong <i>p</i>	Strong <i>n</i>
3889.362	200	30	5638 ₂ —31342 ₃	2	0.218	1.166	1.384	0	1.819
3889.228	150	20	10532 ₄ —36237 ₃	1	0.029	(1.007)	1.036	0.067	0.920
3882.527	100	10	15673 ₃ —41422 ₃	3?	0.314	(1.248)	0.934	0.941	?
3860.910	200	20	8983 ₂ —34877 ₃	1	0.343	1.299	0.956	0	0.270
3858.31	800	80	2356 ₃ —28267 ₂	1	0.064	1.082	1.146	0.127	0.955
3849.19	1000	70	5638 ₂ —31610 ₂	3	0.170	1.166	0.996	0.340	0.996, 1.166
3833.667	60	5	10532 ₄ —36609 ₃	1	0.245	1.008	1.253	0	0.273
3830.018	200	50	14092 ₁ —40194 ₂	2	0.493	0.018	0.511	0	1.003
3829.686	100	20	16766 ₄ —42871 ₁	3	0.195	1.336	1.141	0.783	1.141, 1.336
3820.728	1000	100	4567 ₄ —30733 ₄	3	0.036	1.237	1.273	0.135	1.255
3811.781	400	40	2356 ₃ —28583 ₃	3	0.137	1.081	0.944	0.405	0.944, 1.081
3800.452	300	50	5638 ₂ —31943 ₂	3	0.435?	(1.164)	1.599?	0.870?	?
3800.38	1000	100	0 ₂ —26305 ₃	2	0.702	0.697	1.399	0	2.804
3787.375	50	4	18381 ₃ —44777 ₄	1	0.034	(1.287)	1.253	0w	1.152
3785.46	3000	250	4567 ₄ —30977 ₅	1	0.027	1.235	1.208	0.108	1.100
3777.658	2000	200	0 ₂ —26463 ₁	1	0.300	0.691	0.991	0	0.391
3768.254	200	10	10508 ₂ —37038 ₂	3	0.280	0.812	1.092	0.564	0.812, 1.092
3765.558	100	10	6572 ₁ —33121 ₂	1	0.150	1.498	1.348	0	1.190
3765.046	100	9	18224 ₃ —44777 ₄	7	0.004	(1.246)	1.242	0	1.244
3764.528	90	8	16163 ₃ —42719 ₂	7	0.004	(1.172)	1.176	0	1.174
3753.225	100	20	17901 ₅ —44537 ₅	3	0.129	1.384	1.256	0.647	1.256, 1.384
3746.810	400	60	14740 ₂ —41422 ₃	1	0.072	1.006	0.934	0.144	0.790
3739.030	150	10	10532 ₄ —37269 ₁	3	0.156	1.007	1.163	0.624	1.007, 1.163
3733.786	1000	100	4567 ₄ —31342 ₃	1	0.147	1.244	1.391	0	0.805
3729.093	150	15	20960 ₃ —47768 ₃	7	0.015	(1.157)	1.142	0	1.084
3726.485	150	15	10508 ₂ —37336 ₁	2	0.330	0.804	0.474	0	1.134
3717.802	1000	100	2356 ₃ —29246 ₁	7	0.011	(1.082)	1.071	0	1.037
3707.374	70	7	6572 ₁ —33538 ₂	1	0.672	1.487	0.815	0	0.143
3696.524	400	40	2356 ₃ —29401 ₂	1	0.668	1.078	1.746	0	-0.258
3682.247	3000	200	0 ₂ —27149 ₂	3	0.301	0.691	0.992	0.602	0.691, 0.992
3675.742	400	150	15673 ₃ —42871 ₁	1	0.103	1.249	1.146	0.310	0.837
3672.304	300	30	17901 ₅ —45124 ₆	7	0.057	(1.383)	1.326	0	1.039
3668.19	100	10	8983 ₂ —36237 ₃	1	0.261	1.303	1.042	0	0.520
3651.838	400	40	4567 ₄ —31943 ₂	3	0.164	1.242	1.406	0.656	1.242, 1.406
3649.106	700	60	2356 ₃ —29752 ₂	1	0.416	1.075	1.491	0.	0.243
3637.594	90	7	5638 ₂ —33121 ₂	3	0.170	1.162	1.332	0.340	1.162, 1.332
3635.425	150	10	5638 ₂ —33137 ₁	2	0.385	1.158	0.773	0	1.543
3630.872	700	100	0 ₂ —27533 ₁	1	0.569	0.692	1.261	0	0.123
3627.850	70	10	24085 ₃ —51641 ₆	1	0.068	(1.142)	1.084	0w	0.791
3620.041	100	10	5521 ₀ —33137 ₁	7	0.778	0.000	0.778	0	0.778
3616.892	2000	200	2356 ₃ —29996 ₃	3	0.142	1.082	1.224	0.423	1.082, 1.224
3615.034	300	30	0 ₂ —27654 ₃	2	0.458	0.696	1.154	0	2.070
3599.867	200	60	16766 ₄ —44537 ₅	1	0.078	1.308	1.230	0.310	0.920
3597.501	60	10	8983 ₂ —36772 ₂	3	0.142	1.298	1.156	0.284	1.156, 1.298
3583,267	100	10	5638 ₂ —33538 ₂	3	0.342	1.163	0.821	0.684	0.821, 1, 163

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st <i>g</i>	2nd <i>g</i>	Zeeman Components	
	Tube	Spark						Strong <i>p</i>	Strong <i>n</i>
3567.360	600	50	6572 ₁ —34596 _i	3	0.528	1.501	0.973	0.528	0.973, 1.501
3564.307	200	30	0 ₂ —28047 _i	7	1.250	(0.696)	1.946	0	-0.554
3536.630	400	50	0 ₂ —28267 ₂	3	0.448	0.695	1.143	0.896	0.695, 1.143
3531.224	200	15	5638 ₂ —33949 ₃	1	0.074	(1.164)	1.090	0.134	0.941
3523.025	1000	100	2356 ₃ —30733 ₄	2	0.191	1.083	1.274	0	1.847
3513.271	300	30	10532 ₄ —38987 _i	3	0.141	1.008	1.149	0.560	1.008, 1.149
3498.988	100	10	4567 ₄ —33139 ₃	1	0.201	1.247	1.448	0	0.644
3497.498	1500	150	0 ₂ —28583 ₃	2	0.251	0.697	0.948	0	1.448
3472.410	800	100	0 ₂ —28790 _i	1	0.268	0.690	0.958	0	0.422
3467.569	150	15	15673 ₃ —44503 ₂	2	0.229	1.250	1.021	0	1.709
3452.304	70	10	5638 ₂ —34596 _i	2	0.193	1.164	0.971	0	1.357
3448.284	100	8		7				0	1.491
3441.835	150	8	14740 ₂ —43786 _i	2	0.834	1.003	0.169	0	1.837
3438.428	300	30	5521 ₀ —34596 _i	2	0.969	0.000	0.969	0	0.969
3427.430	150	20	8983 ₂ —38151 _i	1	0.134	1.304	1.438	0.134	1.170
3419.171	500	90	5638 ₂ —34877 ₃	1	0.205	1.156	0.951	0	0.540
3417.34	300	30	2356 ₃ —31610 ₂	2	0.077	1.088	1.011	0.154	1.242
3412.374	100	10	14541 ₃ —43838 ₄	2	0.208	1.118	1.326	0	1.950
3407.140	50	10	8983 ₂ —38325 ₂	3	0.150	1.302	1.152	0.301	1.152, 1.302
3402.512	200	20	4567 ₄ —33949 ₃	2	0.150	1.239	1.089	0	1.689
3397.602	100	20	8983 ₂ —38407 ₃	7	0.013	(1.300)	1.287	0	1.262
3397.257	200	20	4567 ₄ —33995 ₄	3	0.206	1.238	1.032	0.827	1.032, 1.238
3392.815	150	40	17901 ₅ —47366 ₅	3	0.065	1.362	1.297	0.326	1.329
3386.214	150	20	16766 ₄ —46289 ₄	3	0.060	1.33	1.27	0.239	1.24?
3372.201	60	5	5638 ₂ —35284 _i	2	0.112	1.173	1.061	0	1.285
3366.681	100	20	14092 ₁ —43786 _i	3	0.142	0.030	0.172	0.142	0.000, 0.172
3360.060	200	30	0 ₂ —29752 ₂	3	0.806	0.690	1.496	1.612	0.690, 1.496
3358.965	100	20	5521 ₀ —35284 _i	7	1.055	0.000	1.055	0	1.055
3332.737	600	100	0 ₂ —29996 ₃	2	0.524	0.697	1.221	0	2.270
3312.869	600	100	2356 ₃ —32533 ₃	3	0.133	1.080	0.947	0.399	0.947, 1.080
3310.274	300	70	6572 ₁ —36772 ₂	1	0.339	1.491	1.152	0	0.813
3309.193	100	10	8983 ₂ —39193 ₃	7	0.004	(1.300)	1.296	0	1.288
3306.110	300	30	4567 ₄ —34805 ₄	3	0.237	1.232	0.995	0.949	0.995, 1.232
3293.116	60	4	14017 ₁ —44375 ₂	2?	0.805	0.537	1.342	0	2.147
3291.043	150	100	6572 ₁ —36949 _i	3	0.955	1.498	0.543	0.955	0.543, 1.498
3287.286	70	10	14092 ₁ —44503 ₂	2	0.992	0.009	1.001	0	1.993
3282.977	100	40	8983 ₂ —39425 ₂	?	0.04	(1.300)	1.34	0	1.32
3267.165	80	10	5638 ₂ —36237 ₃	1	0.123	1.173	1.050	0	0.804
3267.000	70	10	16766 ₄ —47366 ₅	1	0.019	(1.341)	1.322	0w	1.245
3265.281	80	10	15673 ₃ —46289 ₄	2	0.020	(1.248)	1.268	0w	1.330
3262.469	100	15	10532 ₄ —41175 ₄	3	0.215	0.988	1.203	0.860	0.988, 1.203
3249.529	200	20	2356 ₃ —33121 ₂	1	0.263	1.086	1.349	0	0.559
3247.67	400	80	2356 ₃ —33139 ₃	3	0.356	1.082	1.438	1.067	1.082, 1.438
3243.343	100	10	16766 ₄ —47590 ₃	7	0.005	(1.341)	1.346	0	1.326
3239.393	80	8		7				0	1.428

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st <i>g</i>	2nd <i>g</i>	Zeeman Components	
	Tube	Spark						Strong <i>p</i>	Strong <i>n</i>
3236.76	100	10	4567 ₄ —35453 ₃	2	0.238	1.240	1.002	0	1.953
3230.058	100	10		7				0	1.224
3218.770	70	5	14740 ₂ —47599 ₁	1	0.419	(1.007)	1.426	0	0.588
3213.708	70	5	14541 ₃ —45649 ₃	3	0.094	1.093	1.187	0.282	1.140
3210.965	100	10	5638 ₂ —36772 ₂	7	0.010	(1.164)	1.154	0	1.159
3206.108	150	30	2356 ₃ —33538 ₂	2	0.263	1.079	0.816	0	1.605
3196.916	60	10	6572 ₁ —37843 ₀	7	1.496	1.496	0	0	1.496
3189.632	100	20	0 ₂ —31342 ₃	2	0.688	0.692	1.380	0	2.756
3181.148	70	10	4567 ₄ —35993 ₅	1	0.108	(1.240)	1.132	0w	0.701
3181.008	80	10	5521 ₀ —36949 ₁	7	0.530	0.000	0.530	0	0.530
3178.436	40	5	14541 ₃ —45994 ₃	?	0.480?	(1.085)	0.605?	0w	0.845?
§3174.882	30	6	17901 ₅ —49389 ₃	3	0.334	1.383	?	1.572	1.193, 1.544
3172.949	300	70	4567 ₄ —36075 ₄	3	0.177	1.237	1.060	0.700	1.060, 1.237
§3168.390	100	40	10508 ₂ —42061 ₃ ?	7	0.027	(0.805)	0.832?	0	0.886
3165.730	50	10	6572 ₁ —38151 ₁	7	0.070	(1.496)	1.426	0	1.461
3164.385	100	20	2356 ₃ —33949 ₃	7	0.000	1.082	1.082	0	1.082
§3162.575	300	30	0 ₂ —31610 ₂	3	0.304	(0.696)	1.000	0.608	?
3161.536	20	3	14435 ₂ —46056 ₂	3	0.200	0.896	0.696?	0.410	0.698, 0.892
§3159.84	300	40	2356 ₃ —33994 ₂	2	0.150	1.078	0.928	0.334w	1.378
3156.688	200	100	4567 ₄ —36237 ₃	2	0.198	1.250	1.052	0	1.843
3151.640	80	20	8983 ₂ —40704 ₁	2	0.153	1.302	1.149	0	1.455
3148.415	100	40	6572 ₁ —38325 ₂	1	0.346	1.500	1.154	0	0.808
3137.520	70	30	10532 ₄ —42395 ₃	1	0.043	(1.007)	1.050	0.155w	0.879
3131.812	400	200	10532 ₄ —42453 ₄	7	0.000	1.034	1.034	0	1.034
3119.980	100	40	4567 ₄ —36609 ₃	7	0.008	(1.240)	1.248	0	1.215
3096.764	150	40	4567 ₄ —36850 ₄	3	0.169	1.216	1.047	0.677	0.667—1.597
3080.842	200	50	2356 ₃ —34805 ₄	1	0.090	(1.082)	0.992	0.196	0.720
§3074.789	100	40	5638 ₂ —38151 ₁	1?	0.277	1.159	1.436?	0	1.436
3074.104	60	20	2356 ₃ —34877 ₃	3	0.125	1.070	0.945	0.374	0.785—1.229
3072.881	400	100	0 ₂ —32533 ₃	2	0.263	0.687	0.950	0	1.477
3069.213	80	15	10532 ₄ —43104 ₂	1	0.065	0.990	1.055	0.194w	0.796
3067.426	200	40	2356 ₃ —34947 ₂	1	0.088	1.095	1.183	0.175w	0.920
3063.778	80	10	5521 ₀ —38151 ₁	7	1.436	0.000	1.436	0	1.436
3057.010	400	100	4567 ₄ —37269 ₄	3	0.077	1.242	1.165	0.309	1.204
3050.760	300	80	5638 ₂ —38407 ₃	2	0.130	1.155	1.285	0.261	1.546
3049.300	60	15	8983 ₂ —41768 ₂	3	0.374	1.300	0.926	0.748	0.926, 1.300
3042.085	30	4	6572 ₁ —39435 ₂	1	0.155	1.518	1.363	0.155	1.208
3020.530	300	100	2356 ₃ —35453 ₃	3	0.083	1.084	1.001	0.247	0.842—1.243
3018.30	250	70	0 ₂ —33121 ₂	3	0.647	0.688	1.335	1.299	0.688, 1.335
3016.80	200	50	0 ₂ —33137 ₁	1	0.066	(0.696)	0.762	0w	0.630
3016.69	150	40	0 ₂ —33139 ₃	2	0.742	0.698	1.440	0	2.924
3005.556	300	100	10532 ₄ —43794 ₄	3	0.025	1.013	1.038	0.100	1.026
2984.058	50	10	8983 ₂ —42485 ₁	2	0.442	1.296	0.854	0	1.738
2982.727	150	40	10532 ₄ —44049 ₃	7	0.017	(1.007)	1.024	0	0.955
2980.815	500	100	0 ₂ —33538 ₂	3	0.133	0.697	0.830	0.266	0.536—0.990

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st g	2nd g	Zeeman Components	
	Tube	Spark						Strong p	Strong n
2979.288	100	30	5638 ₂ —39193 ₃	2	0.125	1.153	1.278	0	1.527
2973.390	100	30	6572 ₁ —40194 ₂	1	0.992	1.503	0.511	0	-0.481
2966.953	150	30	6572 ₁ —40267 ₂	1	0.418	1.500	1.082	0	0.664
2964.885	400	80	2356 ₃ —36075 ₄	7	0.012	(1.082)	1.070	0	1.035
2958.01	300	40	5638 ₂ —39435 ₂	3	0.200	1.157	1.357	0.400	1, 157, 1, 357
2954.201	500	100	4567 ₄ —38407 ₃	1	0.048	1.264	1.312	0.144	1.120
2950.67	600	100	2356 ₃ —36237 ₃	3	0.035	1.080	1.045	0.104	1.062
2944.71	200	40	0 ₂ —33949 ₃	2	0.390	0.698	1.088	0	1.867
2940.762	800	100	0 ₂ —33994 ₂	3	0.243	0.696	0.939	0.486	0.696, 0.939
2935.365	40	2	14541 ₃ —48598 ₃	7	0.580?	(1.085)	0.505?	0	0.795
2929.895	200	50	8983 ₂ —43104 ₃	1	0.214	1.296	1.082	0	0.654
2924.613	150	20	5521 ₀ —39704 ₁	7	0.612	0.000	0.612	0	0.612
2918.591	300	40	2356 ₃ —36609 ₃	3	0.175	1.087	1.262	0.525	1.087, 1.262
2916.48	800	100	4567 ₄ —38845 ₅	1	0.062	1.270	1.208	0.248	0.960
2904.760	300	60	2356 ₃ —36772 ₂	1	0.071	1.078	1.149	0.142	0.936
2904.412	400	70	4567 ₄ —38987 ₄	3	0.095	1.232	1.137	0.368	1.137, 1.232
2898.256	500	50	2356 ₃ —36850 ₁	7	0.006	(1.082)	1.076	0	1.060
2896.260	10		16163 ₃ —50680 ₃	7	0.062?	(1.172)	1.110?	0w	1.094
2892.565	60	7	6572 ₁ —41133 ₀	7	1.493	1.493	0.000	0	1.493
2889.62	300	50	0 ₂ —34596 ₁	1	0.276	0.694	0.970	0	0.418
2887.542	100	30	6572 ₁ —41193 ₁	3?	0.171	1.490	1.319	0.171	1.404
2887.132	200	60	4567 ₄ —39193 ₃	1	0.040	1.228	1.268	0.122	1.106
2877.18	80	7	10508 ₂ —45254 ₂	3	0.106	0.932?	1.038?	0.213	0.984
2867.70	60	7	8983 ₂ —43844 ₁	7	0.055	(1.300)	1.355	0	1.245
2866.373	500	100	0 ₂ —34877 ₃	2	0.263	0.697	0.960	0	1.487
2863.41	60	4	2356 ₃ —37269 ₁	2	0.066	1.103	1.169	0.198	1.367
2860.558	100	15	0 ₂ —34947 ₂	3	0.454	0.705	1.159	?	0.705, 1.159
2850.967	100	20	5638 ₂ —40704 ₁	7	0.011	(1.164)	1.153	0	1.175
2845.832	200	20	5638 ₂ —40767 ₃	2	0.045	1.160	1.205	0.091	1.296
2841.493	70	7	5521 ₀ —40704 ₁	7	1.158	0.000	1.158	0	1.158
2834.130	60	10	8983 ₂ —44257 ₁	2	0.084	(1.300)	1.216	0	1.384
2833.285	150	20	0 ₂ —35284 ₁	1	0.353	0.698	1.051	0	0.345
2819.746	100	15	0 ₂ —35453 ₃	2	0.303	(0.696)	0.999	0.605	?
2818.942	60	5	6572 ₁ —42036 ₁	3	0.270	(1.496)	1.226	0.266	1.124, 1.398
2817.685	100	10	8983 ₂ —44463 ₃	2	0.000	(1.300)	1.300?	0w	1.299
2783.698	60	10	6572 ₁ —42485 ₁	3	0.636	1.500	0.864	0.634	0.864, 1.500
2779.370	150	30	2356 ₃ —38325 ₂	1	0.076	(1.082)	1.158	0w	0.930
2766.966	80	10	5638 ₂ —41768 ₂	3	0.237	1.163	0.926	0.472	0.926, 1.163
2762.688	60	10	5638 ₂ —41824 ₃	1	0.033	(1.164)	1.131	0w	1.064
2761.634	200	20	4567 ₄ —40767 ₃	7	0.014	(1.240)	1.226	0	1.282
2758.771	80	10	0 ₂ —36237 ₃	2	0.344	0.700	1.044	0	1.732
2743.637	100	20	5638 ₂ —42075 ₂	3	0.068	(1.164)	1.232	d	1.198
2737.816	50	3	5521 ₀ —42036 ₁	7	1.232	0.000	1.232	0	1.232
2730.700	50	5	0 ₂ —36609 ₃	2	0.554	0.702	1.256	0	2.364
2729.098	40	5	2356 ₃ —38987 ₄	2	0.058	(1.082)	1.140	0w	1.312

Appendix A. Zeeman Data, Hf I—Continued

1	2	3	4	5	6	7	8	9	10
Wavelength Å Air	Intensity		Classification	Zee- man Type	Δg	1st g	2nd g	Zeeman Components	
	Tube	Spark						Strong p	Strong n
2726.70	60	7	5638 ₂ —42302 ₂	3	0.294	1.155	0.861	0.588	0.861, 1.155
2718.593	50	10	0 ₂ —36772 ₂	3	0.460	0.695	1.155	0.957	0.695, 1.155
2713.837	50	5	2356 ₃ —39193 ₃	3	0.206	1.076	1.282	0.618	1.076, 1.282
2705.612	100	20	0 ₂ —36949 ₁	2	0.185	(0.696)	0.511	0	0.881
2699.632	70	10		7				0	1.492
2696.180	80	10	2356 ₃ —39435 ₂	1	0.268	1.076	1.344	0	0.540
2668.290	90	6	5638 ₂ —43104 ₃	1	0.070	(1.164)	1.094	0w	0.954
§2652.781	50	1	6572 ₁ —44257 ₁	7				0	1.006?
2642.751	80	6	4567 ₄ —42395 ₃	2	0.165	(1.240)	1.075	0w	1.736
2642.076	60	2	2356 ₃ —40194 ₂	2	0.573	1.084	0.511	0	2.230?
2636.997	50	5	2356 ₃ —40267 ₂	7	0.000	(1.082)	1.082	0	1.083
2616.606	80	8	5638 ₂ —43844 ₁	1	0.207	1.163	1.370	0	0.956
2612.585	40	1	5521 ₀ —43786 ₁	7	0.170	0.000	0.170	0	0.170
2608.450	60	5	0 ₂ —38325 ₂	3	0.457	0.694	1.151	0.915	0.694, 1.151
§2574.896	50	2	5638 ₂ —44463 ₃	?	0.120?	(1.164)	1.284?	0.120	1.205
2517.858	30		0 ₂ —39704 ₁	7	0.052	(0.696)	0.644	0	0.748

§ Notes on discordant Zeeman patterns:

- | λ | Remarks |
|-----------|--|
| 5886.31 | Classification appears correct. Δg for observed levels = 0.467. Observed pattern gives Δg = 0.462 by assuming $J=3$. |
| 5614.004 | Pattern recorded for Hf II appears to belong to Hf I. |
| 5497.301 | Resolved pattern T ₁ , Δg = 0.18, $J=2$ $g=1.21$; $J=1$ $g=1.39$. This does not fit present classification. |
| 5371.80 | Line classified as Hf II. Observed pattern appears to fit Hf I. T ₁ ? Δg = 0.55, $J=3$ $g=1.10$; $J=2$ $g=1.65$. |
| 5153.122 | Well-resolved pattern; not used in deriving mean g -values. Discordance unexplained. |
| 4932.260 | Observed pattern does not fit classification. If T ₃ is assumed, Δg = 0.184 as compared with Δg = 0.171 from other observations. |
| 4379.064 | Observed pattern recorded by W.F.M. for λ 4379.175 appears to belong with λ 4379.064. |
| 3174.882 | Well-resolved pattern does not fit classification except for type. |
| 3168.390 | Classification seems reasonable. Further confirmation needed for g -value of higher level. |
| 3162.575 | Blend with Hf II. |
| 3159.84 | Observed pattern fits classification 2356 ₃ —33994 ₂ , $o-c=-17\text{ cm}^{-1}$; Classification 2356 ₃ —33994 ₁ gives $o-c=-2\text{ cm}^{-1}$. |
| 3074.789 | Resolved pattern recorded as T ₂ . T ₁ has been assumed, giving $g=1.436$ for higher level. |
| 2887.542 | Resolved pattern recorded as T ₂ . T ₃ has been assumed. |
| 2652.781 | Classification appears correct. Discordance in observed pattern not explained. |
| 2574.896 | Published type is T ₃ . Observed p-component assumed to be Δg ; n-component unexplained. |

1	2	3	4	5	6	Classification	Wavelength air (Å)	Wave number cm ⁻¹	Wavelength air (Å)	Intensity	Tube	Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
Intensity	Tube	Spark	Intensity	Tube	Spark	Intensity	Tube	Spark	Intensity	Tube	Spark	Intensity	Tube	Spark	
12043.08	6		8301.25	0.00		17901 ₅ —26202 ₃	10868.44	20	9198.43	0.00			25678 ₃ —34877 ₃		
11960.80	2		8358.36	+0.08		14092 ₁ —22450 ₂	10859.40	1	9206.09	+0.02			32553 ₃ —41739 ₃		
11766.95	10		8496.05	+0.01		5521 ₀ —14017 ₁	10851.65	6	9212.67	-0.01			31054 ₃ —40267 ₃		
11602.16	4		8616.73	+0.15		20784 ₁ —29401 _{2?}	10815.24	2	9243.68						
11480.61	15		8707.95	+0.02		14740 ₂ —23448 ₃	10784.36	10	9270.15						
11393.12	1		8774.82	+0.08		18143 ₁ —26918 ₁	10772.33	15	9280.50	-0.01			23252 ₄ —32533 ₃		
11365.02	25	7	8796.52	+0.01		5638 ₂ —14435 ₂	10762.68	3	9288.82	+0.03			30146 ₂ —39435 ₂		
11303.44	10		8844.44	+0.02		20908 ₂ —29752 ₂	10756.97	1	9293.75	-0.03			31342 ₃ —40636 ₂		
11296.74	1		8849.69	+0.16		18224 ₄ —27074 _{4?}	10755.89	1	9294.69	+0.07			38407 ₃ —47702 ₂		
11242.16	3		8892.65	+0.06		14435 ₂ —23327 ₂	10698.21	1	9344.80	+0.04			27074 ₄ —36419 ₃		
11229.01	15		8903.07	+0.02		5638 ₂ —14541 ₃	10661.35	2							
11227.70	10		8904.11	+0.04		14740 ₂ —23644 ₃	10642.30	1					35993 ₃ —45387 ₄		
11219.28	1		8910.79	+0.09		25084 ₂ —33994 ₂	10637.93	150					3983 ₂ —18381 ₃		
11190.17	1		8933.97	+0.01		35115 ₂ —44049 ₃	10634.81	5					27018 ₅ —36419 ₃		
11139.05	20		8974.97	-0.01		27018 ₅ —35993 ₅	10622.14	12					22199 ₃ —31610 ₂		
11092.58	1		9012.57	+0.05		37269 ₄ —46282 ₄	10594.89	50					9435.93	0.00	16766 ₄ —26202 ₃
11074.42	5		9027.35	+0.05		8983 ₂ —18011 ₂	10588.44	1					9441.68		
11046.97	40		9049.78	0.00		26943 ₆ —35993 ₅	10550.85	100					9475.31	0.00	26943 ₆ —36419 ₃
11039.01	4		9056.30	{+0.01}		27018 ₅ —36075 ₄	10547.44	1					9478.38	+0.06	33538 ₃ —43016 ₂
11030.13	20	1	9063.59	{+0.01}		36609 ₃ —45666 ₂	10545.50	7					9480.12		
11000.00	3		9088.42	+0.03		22880 ₃ —31943 ₂	10529.38	2					9494.63	+0.05	33994 ₄ —43448 ₃
10971.61	50	5	9111.94	+0.02		20908 ₂ —29996 ₃	10527.28	25					9496.53	-0.01	26922 ₄ —36419 ₅
10953.12	4		9127.32	+0.03		15673 ₃ —24785 ₄	10517.74	1					9505.14	{+0.04}	27533 ₁ —37038 ₂
10938.08	2		9139.87	{+0.06}		25678 ₃ —34805 ₄	10499.16	1					9521.96	{+0.08}	41175 ₄ —50680 ₃
10933.82	10		9143.43	{-0.09}		31054 ₃ —40194 ₂	10496.77	3					9524.13	0.00	26715 ₃ —36237 ₃
10923.38	2		9152.17	+0.07		41739 ₃ —50879 ₂	10484.44	3					95281 ₃ —34805 ₄	+0.05	
10914.47	50		9159.64	-0.01		22199 ₃ —31342 ₃	10480.21	200					9535.33	-0.03	27074 ₄ —36609 ₃
10900.75	15	5	9171.17			25444 ₀ —34596 ₁	10479.20	1					9539.18	0.00	16766 ₄ —26305 ₃
10882.85	1		9186.25			8983 ₂ —18143 ₁	10472.68	1					9546.04	+0.09	33949 ₃ —43448 ₃
10876.28	1		9191.80	+0.05		31575 ₄ —40767 ₃	10457.92	1					9559.51	-0.04	41298 ₂ —50357 ₃

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹
10445.17	7	9571.18	+0.03	41824 ₃ —51395 ₃	10088.51	40	8	9909.55	-0.02	24085 ₃ —33994 ₄	15673 ₃ —25634 ₂
10438.63	2	9577.18			10036.53	150	40	9960.87	-0.01		
10423.78	400	9590.82	+0.01	6572 ₁ —16163 ₂	10023.30	2		9974.02	0.00	4567 ₄ —14541 ₃	31054 ₃ —41175 ₄
10418.99	6	9595.23	+0.01	25281 ₃ —34877 ₃	9877.96	1		10120.77	+0.05		
10414.09	.3	9599.74	+0.06	31575 ₄ —41175 ₄	9864.37	10		10134.72	+0.06	26715 ₃ —36850 ₄	
10405.51	5	9607.66	-0.05	42360 ₃ —51968 ₄	9828.22	15	4	10171.99	-0.01	25281 ₃ —35453 ₃	27074 ₄ —37269 ₄
10397.45	200	9615.11	-0.01	17901 ₅ —27516 ₄	9805.71	2		10195.34	0.00		25084 ₂ —35284 ₁
10389.01	1	9622.92			9801.09	10	4	10200.15	-0.01		
10388.31	8	9623.57			9793.40	1		10208.16		23327 ₂ —33538 ₂	
10377.83	2	9633.29			9791.20	1		10210.45	{+0.02 -0.06}	32091 ₁ —42302 ₂	
10361.40	2	9648.56	+0.05	38289 ₂ —47937 ₂	9754.43	1		10248.94	+0.04	31575 ₄ —41824 ₃	27018 ₅ —37269 ₄
10342.55	3	9666.15	+0.02	25281 ₃ —34947 ₂	9752.40	20	10	10251.08	-0.01		
10319.65	2	9687.60	+0.04	31610 ₂ —41298 ₂	9746.45	2		10257.33			
10312.19	1	9694.60			9737.93	4	1	10266.31			
10293.33	1	9712.37			9722.30	4	1	10282.81	-0.03	27018 ₅ —37301 ₆	
10259.67	10	9744.23	0.00	22199 ₃ —31943 ₄	9716.80	3		10288.63	0.00	35993 ₆ —46282 ₄	
10259.15	30	9744.73	-0.01	22199 ₃ —31943 ₂	9697.66	15	3	10308.94	0.00	8933 ₂ —19292 ₃	
10227.18	20	9775.19	-0.02	25678 ₃ —35453 ₃	9673.88	10	2	10334.28	+0.04	22199 ₃ —32533 ₃	
10209.56	1	9792.06	{-0.02 -0.03}	29996 ₃ —39788 ₂	9662.40	1		10346.56			
10208.74	2	9792.84	-0.04	38289 ₂ —48081 ₃	9654.41	3		10355.12	+0.01	19791 ₂ —30146 ₂	
10207.78	8	9793.77	0.00	23327 ₂ —33121 ₂	9652.05	50	7	10357.65	+0.01	26943 ₆ —37301 ₆	
10203.90	2	9797.49	{+0.01 -0.01}	28527 ₁ —38325 ₂	9628.91	1		10382.54	+0.02	36669 ₃ —46992 ₄	
10190.70	2	.9810.18	0.00	39193 ₃ —48991 ₂	9616.05	5	2	10396.43	0.00	25678 ₃ —36075 ₄	
10184.18	1	9816.46		23327 ₂ —33137 ₁	9613.15	3		10399.57	+0.02	10508 ₂ —20908 ₂	
10181.45	2	9819.09	+0.05	18381 ₂ —28200 ₂	9587.35	5		10427.55	0.00	10532 ₄ —20960 ₄	
10168.81	20	9831.30	+0.01	27018 ₅ —36850 ₄	9581.37	10	3	10434.06	-0.01	20908 ₂ —31342 ₃	
10135.30	6	9863.80	+0.01	25084 ₂ —34947 ₂	9566.01	1		10450.81	+0.01	3160 ₃ —42061 ₃	
10120.15	3	9878.57	0.00	33137 ₁ —43016 ₂	9563.26	200	50	10453.82	+0.01	14740 ₂ —25194 ₁	
10112.20	10	9886.33	+0.01	23252 ₄ —33139 ₃	9553.63	1		10464.36		28790 ₅ —39286 ₁	
10103.88	15	9894.48	0.00	26715 ₃ —36609 ₃	9524.87	1		10495.95	{+0.01 +0.06}	36850 ₄ —47345 ₃	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification	
	Intensity		Wave number cm ⁻¹		Wave number cm ⁻¹		Wave number cm ⁻¹		Intensity			
Wave-length air (Å)	Tube	Spark						Tube	Spark	cm ⁻¹	cm ⁻¹	
9514.37	8	3	10507.54	10508.89	+0.01	0 ₂ —10508 ₂ ^a	9306.16	1	10741.90	0.00	23252 ₄ —33994 ₄	
9513.14	600	100	10516.68	-0.03	29996 ₃ —40513 ₂ ^a	9299.95	60	2	10742.62	+0.01	30733 ₄ —41475 ₃	
9506.10	2		10524.75	+0.01	5638 ₂ —16163 ₂ ^a	9295.63	15	5	10749.80	0.00	16766 ₄ —27516 ₄	
9498.81	30	3	10530.72			9282.54	4	1	10754.79	+0.01	16163 ₂ —26918 ₁	
9493.42	1								10769.96	+0.02	31054 ₃ —41824 ₃	
9483.52	1		10541.72	-0.09	34991 ₁ —45538 ₆ ^a	9250.25	1000	150	10807.55	0.00	8983 ₂ —19791 ₂	
9482.83	10	1	10542.48	-0.02	14541 ₃ —25084 ₂ ^a	9243.18	1		10815.82			
9474.26	1		10552.02	-0.01	16163 ₃ —26715 ₃ ^a	9216.86	10		10846.71	+0.01	14435 ₂ —25281 ₃	
9472.01	1		10554.53	+0.07	26715 ₃ —37269 ₄ ^a	9193.30	300	30	10874.50	-0.02	14092 ₁ —24966 ₆	
9469.05	1		10557.83	+0.11	30146 ₂ —40704 ₁ ^a	9182.14	250	40	10887.72	-0.01	16766 ₄ —27654 ₃	
9468.25	12	2	10558.72	-0.01	25678 ₃ —36237 ₃ ^a	9179.30	4		10891.09			
9453.75	12	2	10574.91	0.00	26463 ₁ —37038 ₂ ^a	9177.23	100	8	10893.54	+0.01	14740 ₂ —25634 ₂	
9412.23	2		10621.56	-0.01	23327 ₂ —33949 ₃ ^a	9158.55	9		10915.76			
9405.18	1		10629.52			9153.00	2		10922.38	-0.02	22199 ₃ —33121 ₂	
9404.14	4	2	10630.70			9145.58	3		10931.24	-0.01	25678 ₃ —36609 ₃	
9402.57	50	4	10632.47	+0.01	15673 ₃ —26305 ₃ ^a	9138.20	30	3	10940.07	+0.02	22199 ₃ —33139 ₃	
9389.91	1		10646.81			9093.88	2		10993.39	+0.01	28200 ₂ —39193 ₃	
9387.94	2		10649.04	0.00	14435 ₂ —25084 ₂ ^a	9052.35	10	3	11043.82	0.00	20908 ₂ —31952 ₁	
9387.54	3		10649.50	+0.03	31119 ₂ —41768 ₂ ^a	9035.66	1		11064.22	+0.01	31952 ₁ —43016 ₂	
9380.14	50	7	10655.90	0.00	22880 ₃ —33538 ₂ ^a	9031.77	2		11068.99	{-0.05	22880 ₃ —33949 ₃	
9372.00	1		10667.15	0.00	23327 ₂ —33994 ₂ ^a					{-0.02	39788 ₂ —50857 ₃	
9365.75	3		10674.27			9004.74	200	20	11102.21	-0.01	14092 ₁ —25194 ₁	
9359.86	1		10680.99			8994.77	30	2	11114.52	+0.05	22880 ₃ —33994 ₄	
9346.32	150	20	10696.46	-0.01	23252 ₄ —33949 ₃ ^a	8976.65	20		11136.96	+0.01	14541 ₃ —25678 ₃	
9342.00	2		10701.41	0.00	34947 ₂ —45649 ₃ ^a	8967.15	10		11148.75	+0.10	46966 ₃ —58115 ₂	
9341.17	3		10702.36	-0.01	20908 ₂ —31610 ₂ ^a	8958.89	20		11159.03	+0.08	20784 ₁ —31943 ₂	
9325.14	80	10	10720.76	0.00	24085 ₅ —34809 ₄ ^a	8952.14	5		11167.45	+0.07	20784 ₁ —31952 ₁	
9314.46	2		10733.05	{-0.04	35115 ₂ —45948 ₂ ^a	8927.24	3		11198.60	-0.02	30977 ₃ —42175 ₄	
9313.65	2		10733.98	{-0.01	26305 ₃ —37038 ₂ ^a	8918.06	2		11210.12		35453 ₃ —46678 ₄	
9308.29	9		10740.16	0.00	14541 ₃ —25281 ₃ ^a	8906.81	1		11224.28	-0.05		
										4	11230.27	

Appendix B. Observed and Classified Lines of Hf I—Continued

1		2		3		4		5		6		
Wavelength air (Å)		Intensity		Wave number cm ⁻¹		Classification		Wavelength air (Å)		Intensity		
Tube	Spark	Tube	Spark	Tube	Spark	Tube	Spark	Tube	Spark	Tube	Spark	
8888.43	1	11247.49	+0.02	31054 ₃ —42302 ₃	8661.68	40	4	11541.93	-0.01	14092 ₁ —25634 ₂		
8886.72	3	11249.66			8659.03	6		11545.47	{-0.04	29752 ₂ —41298 ₂		
8876.17	5	11263.03							{0.00	31943 ₂ —43489 ₃		
8875.92	10	11263.35	0.00	19791 ₂ —31054 ₃	8658.23	20	2	11546.53	-0.01	28583 ₃ —40130 ₂		
8871.65	1	11268.77	+0.01	23327 ₂ —34596 ₁	8657.60	1		11547.37				
				8657.41		2		11547.63	-0.13	38845 ₃ —50393 ₄		
8845.95	5	11301.51	-0.03	29996 ₃ —41298 ₂	8656.12	7	1	11549.35	+0.02	23327 ₂ —34877 ₃		
8841.99	20	11306.57	+0.03	30977 ₃ —42283 ₄	8655.40	5		11550.31	0.00	30733 ₄ —42283 ₄		
8828.79	1	11323.47			8653.35	2		11553.04	0.05	23252 ₄ —34895 ₅		
8825.24	20	2	11328.03	{-0.01	25281 ₃ —36609 ₃	6644.31	20	2	11565.13	+0.02	14740 ₂ —26305 ₃	
8821.12	1	11333.32	{+0.12	19791 ₂ —31119 ₂ [?]	8840.04	2500Z	500	2	11570.84	-0.01	6572 ₁ —18143 ₁	
			{+0.02	27074 ₄ —38407 ₃								
8815.11	3	11341.04	+0.02	31054 ₃ —42305 ₃	8636.36	10	1?	11575.77				
8795.54	4	11366.28	-0.01	31119 ₂ —42485 ₁	8628.28	1		11586.61	0.00	34596 ₁ —46118 ₂		
8767.04	1	11403.23	-0.02	34877 ₃ —46280 ₃	8624.83	20	2	11591.25	+0.02	25678 ₃ —37269 ₁		
8765.43	1	11405.32	{0.00	34877 ₃ —46282 ₄	8614.81	1		11604.73				
8765.17	6	11405.66	{-0.04	38987 ₄ —50393 ₄	8610.86	7	1	11610.05	-0.03	26715 ₃ —38325 ₂		
			{0.00	31610 ₂ —43016 ₂								
8764.71	1	11406.26	-0.01	36772 ₂ —48179 ₂	8609.98	50	6	11611.24	0.00	27516 ₄ —39127 ₃		
8763.88	10	11407.34	+0.01	26918 ₁ —38325 ₂	8603.32	60	8	11620.23	-0.01	23327 ₂ —34947 ₂		
8749.41	20	2	11426.20	-0.02	32091 ₁ —43517 ₂	8599.87	10	1	11624.89	0.00	20908 ₂ —32533 ₃	
8749.15	40	4	11426.54	-0.02	14017 ₁ —25444 ₀	8597.83	5		11627.65	0.00	30733 ₄ —42360 ₃	
8737.03	4	11442.39	0.00	30733 ₄ —42175 ₄	8592.06	20	2	11635.46	+0.03	29246 ₄ —40882 ₃		
8728.66	1	11453.37			8589.89	1		11638.40	0.00	33139 ₃ —44777 ₄		
8716.70	10	11469.08	{-0.02	34991 ₁ —46469 ₁	8587.84	1		11641.17				
8715.58	70	10	11470.56	{0.00	36850 ₄ —48319 ₃	8586.54	8	1	11642.94			
8711.20	600Z	100	11476.32	+0.01	23644 ₃ —35115 ₂	8572.34	1		11662.22			
8709.17	5		11479.00	-0.02	15673 ₃ —27149 ₂	8569.04	80	15	11666.71	+0.02	23448 ₃ —35115 ₂	
					29996 ₃ —41475 ₃							
8690.37	2	11503.83	-0.03	34991 ₁ —46469 ₁	8564.10	1		11673.44				
8689.58	1	11504.88	-0.02	28200 ₂ —39704 ₁	8563.83	2		11673.81				
8683.60	2	11512.80	0.00	25444 ₀ —36949 ₁	8563.66	3		11674.04	+0.08	31342 ₃ —43016 ₂		
8673.87	30	3	11525.71	+0.01	35543 ₃ —49666 ₃	8561.04	1		11677.62	{-0.02	35284 ₁ —46961 ₂	
8671.37	10	1	11529.04	+0.02	25084 ₂ —36609 ₃	8560.59	1		11678.23	{+0.08	46437 ₂ —58115 ₂	
					31575 ₄ —43104 ₃					{+0.05	30146 ₂ —41824 ₃	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification	Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
8558.22	1		11681.46			8434.98	1		11852.14		
8546.43	2500Z	500	11697.58	0.00	6572 ₁ —18270 ₆	8427.38	3		11862.82	-0.01	28267 ₂ —40130 ₂
8532.47	1		11716.72	-0.06	33538 ₂ —45254 ₃	8425.76	10		11865.11	0.00	25084 ₂ —36949 ₁
8527.91	3		11722.98	-0.01	29752 ₂ —41475 ₃	8416.26	2		11878.50	+0.01	31610 ₂ —43489 ₃
8527.70	1		11723.27	{+0.01 -0.02}	14740 ₂ —26463 ₁	8408.11	5		11890.01	+0.01	30146 ₂ —42036 ₁
			28790 ₁ —40513 ₂			8407.84	1		11890.39		
8521.37	1		11731.98	-0.01	33538 ₂ —45270 ₁	8404.89	20	2	11894.57		
8516.03	1		11739.34	0.00	28527 ₁ —40267 ₂	8404.57	3		11895.02	0.00	31942 ₄ —43838 ₄
8514.82	8	1	11741.00	+0.01	28047 ₁ —39788 ₂	8403.23	1		11896.92	+0.01	29401 ₂ —41298 ₂
8514.18	4		11741.89	-0.01	42111 ₁ —53853 ₀	8402.58	2		11897.84	-0.01	31619 ₂ —43517 ₂
8513.69	2		11742.56	-0.01	29996 ₃ —41739 ₃	8399.98	40	3	11901.52	+0.02	26943 ₆ —38845 ₃
			33949 ₃ —45728 ₂			8399.12	3		11902.74		
8513.55	1		11742.76	-0.02	28047 ₁ —39790 ₁	8394.99	20	2	11908.59	0.00	24085 ₅ —35993 ₅
8508.15	50	5	11750.21	+0.01	22199 ₃ —33949 ₃	8391.63	10	2	11913.36	+0.01	27074 ₄ —38987 ₄
8506.53	5		11752.45	+0.01	27533 ₁ —39286 ₁	8385.03	40	5	11922.74	+0.01	26922 ₄ —38845 ₅
8493.16	3		11770.95	0.00	27074 ₄ —38845 ₃	8382.98	100	10	11925.65	-0.01	22880 ₃ —34805 ₄
8487.10	2		11779.35	+0.02	33949 ₃ —45728 ₂	8380.05	80	8	11929.82	-0.02	28583 ₃ —40513 ₂
			11791.91			8376.00	1		11935.59	0.00	36772 ₂ —48708 ₂
8478.06	1		11792.68			8375.38	1		11936.48	+0.01	33538 ₃ —45474 ₁
8477.51	1		11795.65	+0.02	22199 ₃ —33994 ₄	8367.91	1		11947.13	-0.03	36675 ₄ —48022 ₄
8475.37	40	3	11801.10	-0.01	34877 ₃ —46678 ₄	8361.29	20	4	11956.59	-0.02	23327 ₂ —35284 ₁
8471.46	3		11809.60	+0.03	29401 ₂ —41211 ₂	8359.13	2		11959.68	-0.05	36850 ₄ —48809 ₃
8465.36	2				34947 ₃ —46782 ₁	8352.55	5		11969.10	0.00	27018 ₅ —38987 ₄
						8346.36	2		11977.98	-0.02	27149 ₃ —39127 ₃
8460.00	500Z	120	11817.08	-0.01	16766 ₄ —28583 ₃	8344.25	400Z	80	11981.01	0.00	15673 ₃ —27654 ₃
8454.00	60	7	11825.47	+0.01	26463 ₁ —38289 ₂	8340.42	2		11983.61	0.00	26305 ₃ —38289 ₂
8453.26	6	1	11826.51	-0.01	19292 ₃ —31119 ₂	8339.35	2		11986.51	-0.03	29752 ₃ —41739 ₃
8451.69	50	5	11828.70	+0.02	19791 ₂ —31619 ₂	8338.07	60	8	11988.05	+0.03	25281 ₃ —37269 ₄
8447.31	1		11834.84	+0.01	34947 ₃ —46782 ₁	8335.27	2h		11989.89	-0.01	24085 ₅ —36075 ₄
						8342.44	3		11993.92	+0.01	28200 ₂ —40194 ₂
8442.14	1		11842.08	-0.04	32533 ₃ —44375 ₂	8340.42	2				
8441.42	20	2	11843.09	+0.01	15673 ₃ —27516 ₄	8339.35	2				
8440.51	1		11844.37	+0.01	25194 ₁ —37038 ₂	8338.07	60	8			
8439.31	8	1	11846.06	+0.02	28790 ₁ —40636 ₂	8335.27					
8435.65	1		11851.19	+0.02	35453 ₃ —47304 ₂						

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Classification	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	5	6	
							Tube	Spark					
Wavelength air (Å)	Intensity	Wavelength cm ⁻¹	Wavelength air (Å)	Wave number cm ⁻¹	Classification								
8333.19	2	11996.91	+0.11	22880 ₃ —34877 ₃	8244.40	40	5	12126.11	0.00	23327 ₂ —35453 ₃			
8331.12	2	11999.89	-0.01	33994 ₄ —45994 ₃	8238.65	20	2	12134.58	+0.01	27654 ₃ —39788 ₂			
8328.97	6?	12002.99	-0.02	18143 ₁ —30146 ₂	8229.15	3		12148.58	-0.07	33121 ₂ —45270 ₁			
8325.80.	1	12007.56	+0.03	39193 ₃ —51201 ₄	8226.54	1		12152.44	+0.03	35453 ₃ —47606 ₄			
8321.35	2	12013.98	-0.03	34947 ₂ —46961 ₂	8224.59	1		12155.32	0.00	36850 ₄ —49005 ₄			
8318.34	1	12018.33		8224.31	1			12155.73	+0.02	30146 ₂ —42302 ₂			
8317.60	2	12019.40	-0.01	36850 ₄ —48869 ₃	8222.46	20		12158.47					
8316.69	1	12020.71	+0.04	35284 ₁ —47304 ₂	8220.97	3		12160.67	-0.05	34805 ₄ —46966 ₃			
8316.35	1	12021.20		8217.36	15			12166.01	+0.04	32091 ₁ —44257 ₁			
8311.32	1	12028.48	+0.01	35993 ₃ —48022 ₄	8212.15	10	2	12173.73	+0.01	14541 ₃ —26715 ₃			
8305.33	6	12037.15	-0.04	16163 ₂ —28200 ₂	8204.57	20000Z	500	12184.98	0.00	2356 ₃ —14541 ₃			
8301.85	4	12042.20	+0.05	36949 ₁ —48991 ₂	8202.05	6		12188.72	+0.01	31943 ₄ —44132 ₅			
8294.70	4	12052.58	-0.01	28583 ₃ —40636 ₂	8196.61	1		12196.81	-0.04	39193 ₃ —51390 ₄			
8293.41	20	12054.45	+0.01	27231 ₀ —39286 ₁	8193.82	100	10	12200.97	-0.04	23252 ₄ —35453 ₃			
8292.00	15	12056.50		8185.72	4			12213.04	-0.01	20908 ₂ —33121 ₂			
8285.29	1	12066.27		8182.28	1			12218.17					
8284.93	7	12066.79	+0.01	8182.02	1			12218.56	-0.01	36772 ₂ —48991 ₂			
8284.30	6h	12067.71	0.00	22880 ₃ —34947 ₃	8177.25	1h		12225.69	-0.02	33139 ₃ —45364 ₃			
8276.94	10000Z	200	12078.44	0.00	2356 ₃ —14435 ₂	8176.39	1		12226.97	-0.04	35993 ₃ —48220 ₄		
8274.29	5	12082.31	-0.01	28047 ₁ —40130 ₂	8174.92	30	4	12229.17	-0.02	29246 ₄ —41475 ₃			
8269.33	1	12089.56	-0.02	34877 ₃ —46966 ₃	8173.90	300Z	70	12230.70	0.00	20908 ₂ —33139 ₃			
8267.38	1	12092.41	-0.02	28526 ₀ —40618 ₁	8164.96	1		12244.09	+0.01	36075 ₄ —48319 ₃			
8264.53	1	12096.58	-0.02	36772 ₂ —48869 ₃	8163.60	20	2	12246.13	0.00	28267 ₂ —40513 ₂			
8260.39	1	12102.64		8162.04	3			12248.47	+0.09	33139 ₃ —45387 ₄			
8257.75	1	12106.51		8157.59	6			12255.15	-0.01	27533 ₁ —39788 ₂			
8254.57	2	12111.17	-0.05	33538 ₃ —45649 ₃	8154.58	1		12259.68	+0.09	36600 ₃ —48869 ₃			
8251.73	10	12115.34	0.00	34877 ₃ —46992 ₄	8151.54	1		12264.25	-0.02	34596 ₁ —46860 ₂			
8251.15	8	12116.19			8147.19	2		12270.80	-0.01	37269 ₄ —49540 ₅			
8250.58	1	12117.03	0.00	33137 ₁ —45254 ₂	8146.05	5		12272.51	+0.04	26715 ₃ —38987 ₄			
8248.81	100	12119.63	+0.05	36257 ₃ —48356 ₄	8143.62	60			7	12276.18			

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
8140.90	2		12280.28	+0.02	$14435_2^a - 26715_3^a$	8064.09	1		12397.25	-0.03	$34947_2^a - 47345_3^a$
8139.10	30	2	12282.99	-0.01	$19292_3^a - 31575_4^a$	8063.63	1		12397.95	0.00	$14740_2^a - 27149_3^a$
8136.63	15	1	12286.72	0.00	$29996_3^a - 42283_4^a$	8056.47	400		12408.97	{-0.01	$28790_1^a - 41211_2^a$
8136.01	1		12287.66	+0.01	$33994_4^a - 46282_4^a$	8048.82	4		12420.77	{-0.05	$38987_4^a - 51408_5^a$
8128.91	10	1	12298.39	0.00	$28583_3^a - 40832_3^a$	8047.26	8	1	12423.17	-0.02	$31952_1^a - 44375_2^a$
8121.18	5		12310.10	-0.02	$27533_1^a - 39843_0^a$	8034.52	1		12442.87	0.00	$33994_2^a - 46437_2^a$
8118.20	10	1	12314.62	+0.02	$27231_6^a - 39546_1^a$	8032.24	8	1	12446.40	-0.01	$39193_3^a - 51640_4^a$
8107.66	4		12330.62	0.00	$36850_4^a - 49180_5^a$	8010.58	100	15	12480.06	+0.01	$16766_4^a - 29246_4^a$
8106.04	2		12333.09	+0.01	$33949_3^a - 46282_4^a$	8008.68	8	1	12483.02	+0.01	$14435_2^a - 26918_1^a$
8105.36	10	2	12334.12	0.00	$24085_5^a - 36419_3^a$	8007.66	1		12484.61	-0.01	$35453_3^a - 47938_3^a$
8103.67	20	4	12336.70	{+0.09 -0.02}	$20784_1^a - 33121_2^a$ ($33127_1^a - 45474_1^a$)	8002.80	5	1	12492.19		
8094.14	8	1	12351.22	-0.01	$28267_2^a - 40618_1^a$	8002.44	15	1	12492.75	+0.01	$29246_6^a - 41173_9^a$
8092.91	20	4	12353.10	{+0.08 -0.03}	$20784_1^a - 33137_1^a$ ($33127_2^a - 45474_1^a$)	7994.76	5000Z	800	12504.75	-0.03	$56338_2^a - 18143_1^a$
8092.58	1		12353.60	+0.02	$37269_4^a - 49623_4^a$	7990.03	3	4	12512.16		
8091.02	3		12355.98	-0.02	$38845_5^a - 51201_4^a$	7986.90	40	4	12517.06	0.00	$26918_1^a - 39435_2^a$
8087.51	1		12361.35	0.00	$34947_2^a - 47309_1^a$	7980.54	1	1	12527.03	0.00	$33139_3^a - 45666_2^a$
8085.73	15	2	12364.07	+0.01	$29996_3^a - 42360_3^a$	7979.17	2		12527.87	-0.01	$33121_2^a - 45649_3^a$
8085.36	20?		12364.63	0.00	$16163_2^a - 28527_1^a$	7976.95	10	1	12532.67		
8082.62	10	2	12368.82	{+0.01 -0.06}	$10532_4^a - 22901_5^a$ ($28267_2^a - 40636_2^a$)	7976.81	40	5	12532.89	+0.05	$14541_3^a - 27074_4^a$
8080.96	100	20	12371.37	+0.01	$10508_2^a - 22830_3^a$	7972.29	1		12540.00	-0.03	$34805_4^a - 47345_3^a$
						7971.57	20	4	12541.13	+0.03	$22450_2^a - 34991_1^a$
8080.77	50	10	12371.66	-0.01	$14092_1^a - 26463_1^a$	7970.22	1		12543.25		
8080.26	500Z	100	12372.44	+0.01	$5638_2^a - 18011_2^a$	7660.31	4		12558.87	-0.08	$27231_6^a - 39790_1^a$
8076.83	1		12377.69			7957.56	4		12563.21	-0.01	$38845_3^a - 51408_5^a$
8074.30	1		12381.57	+0.01	$36609_3^a - 48991_2^a$	7955.21	30	7	12566.92	+0.03	$28200_2^a - 40767_3^a$
8068.34	3		12390.72	0.00	$37269_4^a - 49660_3^a$	7954.27	15	2	12568.41	+0.03	$35453_3^a - 48022_4^a$
						7952.83	4		12570.68	-0.04	$28047_1^a - 40618_1^a$
						7951.73	3		12572.42	-0.01	$36237_3^a - 48809_3^a$
						7951.00	20	4		0.00	$22880_3^a - 35453_3^a$

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Classification	5	6
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Wave number cm ⁻¹	Wave number cm ⁻¹
Tube	Spark					Tube	Spark	
7950.43	5	1	12574.48	+0.03	36772 ₃ —49347 ₃	7881.12	1	12685.06
7948.63	20	2	12577.32			7877.69	20	12690.59
7940.96	3		12589.47	-0.01	33139 ₃ —45728 ₂	7870.84	1	12701.63
7940.57	2		12590.09	-0.01	35284 ₁ —47874 ₁	7867.26	20	12707.41
7938.06	500Z	100	12594.07	-0.01	15673 ₃ —28267 ₂	7866.58	5	12708.51
7934.70	1		12599.41			7862.78	60	12714.65
7930.77	1		12605.65			7858.52	3	12721.54
7930.04	2		12606.81	-0.01	22199 ₃ —34085 ₄	7858.32	1	12721.87
7929.10	1		12608.30			7857.78	3h	12722.74
7928.69	5		12608.96			7853.81	12	12729.17
7927.19	2		12611.34			7846.57	50	12740.92
7924.08	5		12616.29			7845.37	4000Z	0.00
7920.75	2000Z	400	12621.60	-0.02	5521 ₀ —18143 ₁	7831.81	8	-0.02
7917.36	5		12627.00			7830.60	5	24085 ₅ —36850 ₄
7914.77	4		12631.13	+0.01	36772 ₃ —49433 ₂	7830.08	1	35453 ₃ —48220 ₄
7911.94	1		12635.65			7826.62	4	23252 ₄ —35993 ₃
7910.71	2		12637.61	+0.01	31619 ₂ —44257 ₁	7814.57	400Z	5638 ₂ —18381 ₃
7908.58	1		12641.02	-0.03	27149 ₂ —39790 ₁	7813.50	10	14740 ₂ —27533 ₁
7908.09	2		12641.80			7804.56	2	38845 ₅ —51640 ₄
7907.17	1		12643.27	-0.01	33538 ₃ —46181 ₃	7803.97	4	35450 ₁ —49666 ₃
7906.12	15	2	12644.95	+0.01	33538 ₂ —46183 ₂	7796.82	60	12773.39
7904.88	6		12646.93	+0.08	25678 ₃ —38325 ₂	7790.90	500Z	+0.01
7901.45	8		12652.42	-0.06	38987 ₄ —51640 ₄	7789.52	15	12790.56
7894.01	8?	1	12664.35			7783.88	6	+0.01
7893.75	30	5	12664.77	+0.02	22450 ₂ —35115 ₂	7782.56	1	12843.53
7893.03	4		12665.92	{-0.04	28527 ₁ —41193 ₁	7777.43	10	-0.01
7888.54	20	2	12667.13	-0.01	36772 ₂ —49438 ₂	7776.65	3	32533 ₃ —45387 ₄
7888.01	7	1	12673.98	-0.02	18381 ₃ —31054 ₃	7774.39	5	33139 ₃ —45994 ₃
7885.53	4		12677.97	+0.01	29963 ₃ —42670 ₄	7773.95	2	27654 ₃ —40513 ₂
7884.58	3		12679.50		22199 ₃ —34877 ₃	7773.09	10	30977 ₃ —43838 ₄
								+0.03

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Classification	Intensity			Wave number cm ⁻¹	Classification
							Tube	Spark	Tube		
7762.38	15	2	12879.10	0.00	23644 ₃ —36523 ₃	7678.60	3		13019.62	-0.02	29996 ₃ —43016 ₂
7758.84	1		12884.98	+0.01	34991 ₁ —47876 ₁	7676.53	1		13023.13	0.00	28267 ₂ —41298 ₂
7750.15	2		12899.43			7671.92	20	4	13030.96	0.00	
7749.62	4		12900.31	-0.01	14017 ₁ —26918 ₁	7670.93	3		13032.64	-0.01	31342 ₃ —44375 ₂
7747.94	8	1	12903.11	+0.01	35453 ₃ —48356 ₄	7670.76	1		13032.93	-0.01	
7743.57	150Z	20	12910.39	+0.02	15673 ₃ —28583 ₃	7668.414	20	2	13036.92	+0.03	29246 ₄ —42283 ₄
7741.59	50	10	12913.69	+0.03	14740 ₃ —27654 ₃	7666.09	6		13040.87	+0.02	20908 ₂ —33949 ₃
7740.17	2000Z	400	12916.06	+0.01	10532 ₄ —23448 ₃	7664.749	8	1	13043.15	+0.05	33949 ₃ —46992 ₄
7736.89	10?	1	12921.53			7664.465	20	2	13043.63	{-0.01	25281 ₃ —38325 ₂
7732.42	20	4	12929.00	+0.03	29246 ₄ —42175 ₄	7663.51	5h		13045.26	{+0.03	18011 ₂ —31054 ₃
										+0.07	33137 ₁ —46183 ₂
7725.12	1	1	12941.22						13046.95		
7724.68	10		12941.96	-0.13		7662.52	4		13047.29	+0.01	32091 ₁ —45138 ₂
7723.68	2		12943.63	+0.01		7662.32	2		13050.70	0.00	36609 ₃ —49660 ₃
7717.84	2		12953.43	0.00		7660.318	6	1	13057.39	+0.01	14092 ₁ —27149 ₂
7714.92	1		12958.33	+0.03		7656.39	20	4	13059.78		
						7654.99	1				
7710.25	1		12966.18	-0.01	35115 ₂ —48031 ₃	7653.88	4h		13061.67	+0.07	33121 ₂ —46183 ₂
7709.92	1		12966.73	0.00	29752 ₂ —42719 ₂	7650.39	2		13067.63	+0.07	25084 ₂ —38151 ₁
7706.90	5		12971.82	{+0.06	33994 ₃ —46966 ₃	7648.84	4		13070.28	+0.01	38325 ₂ —51395 ₃
7704.530	30		12975.81	0.00	18143 ₁ —31119 ₂	7646.34	20		13074.55		
7702.171	8		12979.78	-0.01	27533 ₁ —40513 ₂	7645.655	40Z	80	13075.72	0.00	17901 ₅ —30977 ₃
7701.69	3		12980.59	0.00	27149 ₂ —40130 ₂	7624.387	1000		13112.20	+0.01	10532 ₄ —23644 ₃
7699.37	2	3	12984.50	-0.03	23252 ₄ —36237 ₃	7612.60	50	8	13132.50	-0.04	(34805 ₄ —47938 ₃)
7697.38	1		12987.86	-0.07	38407 ₃ —51395 ₃	7608.549	200	40	13139.49	+0.01	14092 ₁ —27231 ₀
7694.10	12	2	12993.40	0.00	28200 ₂ —41193 ₁	7606.39	8	1	13143.22	-0.01	33139 ₃ —46282 ₄
7693.40	4		12994.58	-0.03	31054 ₃ —44049 ₃	7606.03	2		13143.84	-0.04	35115 ₂ —48259 ₁
7685.91	1		13007.24	0.00	34947 ₂ —47955 ₂	7605.27	3		13145.16	0.00	34877 ₃ —48022 ₄
7685.38	2		13008.14			7599.56	40		13155.04	{-0.01	35453 ₃ —48598 ₃
7684.47	1		13009.68	-0.02	37269 ₄ —50279 ₅	7592.977	150Z	30	13166.44	{+0.02	30977 ₃ —44132 ₅
7682.16	2		13013.59	+0.03	36609 ₃ —49623 ₄	7589.67	3		13172.18	-0.01	23252 ₄ —36419 ₅
7679.95	3		13017.34	0.00	33949 ₃ —46966 ₃	7586.80	1		13177.16		

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number o-c cm ⁻¹
7586.26	8	1	13178.10 13180.41	7511.47 7511.00	1 10?		13309.31 13310.14	+0.07 +0.01		25678 ₃ —38987 ₄ 33994 ₂ —47304 ₂	
7584.93	1	12	13184.70 13186.93	7508.77 7506.80	2 3		13314.09 13317.59				
7582.462	70	40	13194.17	7501.63	1		13326.77	+0.01		26463 ₁ —39790 ₁	
7581.18	4	300Z									
7577.02											
7576.67	40	6	13194.78 13208.41	7492.11 7489.02	10 15	1	13343.70 13349.21	0.00 +0.02		34877 ₃ —48220 ₄ 26918 ₁ —40267 ₂	
7568.85	2	40	13216.46	7488.17	30	2	13350.72	+0.01		18224 ₄ —31575 ₄ 22880 ₃ —36237 ₃	
7564.24	200Z	300	13218.75 13226.27	7484.603 7483.704	50 4	4				23252 ₄ —36699 ₃ 34596 ₁ —47955 ₂	
7562.93	1500Z	1									
7558.63											
7557.78	1	40	13227.76 13230.22	7480.781 7479.78	20 15	2	13363.91 13365.70	+0.02 +0.02		27149 ₂ —40513 ₂ 27516 ₄ —40882 ₃	
7556.37	200Z	1	13238.51 13250.50	7476.71 7476.53	4 2	2	13371.18 13371.51	+0.01 +0.09		34947 ₂ —48319 ₃ 30146 ₂ —43517 ₂ 21738 ₁ —35115 ₂	
7551.64	7		13252.97	7473.67	6		13376.62	+0.03			
7544.81	3										
7543.40	50	6									
7542.39	10	1	13254.75 13263.61	7463.905 7462.51	40 3	40	13394.12 13396.63	+0.02 -0.02		23644 ₃ —37038 ₂ 33949 ₃ —47345 ₃	
7537.35	3		13267.55	7461.30	1		13398.80	+0.01		30733 ₄ —44132 ₅ 35453 ₃ —48869 ₃	
7535.11	2		13268.08	7451.94	6		13415.63	0.00			
7534.81	1		13271.48	7450.59	1		13418.06				
7532.88	5										
7532.42	1		13272.29	+0.03							
7530.13	5h		13276.33	+0.01							
7529.21	2		13277.95	0.00							
7526.82	15	2	13282.17	+0.02							
7525.09	2		13285.22								
7520.38	3		13293.54								
7517.49	1		13298.65	+0.05							
7516.79	2		13299.89	+0.05							
7515.22	3		13302.67	0.00							
7513.36	2		13305.96								

1	2	3	4	5	6	Classification	Classification
Wavelength air (Å)	Intensity			Wave number cm ⁻¹	Wave number cm ⁻¹	Wavelength air (Å)	Wave number cm ⁻¹
Tube	Spark					Tube	Spark
7426.67	3			13461.28	-0.01	7359.916	3
7424.274	10	20	2	13465.62	+0.01	7358.78	3
7423.628	120Z			13466.79	-0.01	7356.18	100
7422.416	15			13468.99	0.00	7352.41	1
7420.76	1			13472.00	+0.01	7346.14	3h
7420.48	3			13472.51	+0.01	13583.37	-0.01
7417.51	8	1		13477.90	-0.01	13585.47	{ -0.04
7414.63	20	2		13483.14	+0.02	13590.27	{ -0.05
7412.70	5			13486.65	+0.01	13597.24	+0.03
7409.505	70	12		13492.46	-0.01	13608.84	-0.09
7408.97	30	6		13493.44	0.00		
7402.75	15	1		13504.77	+0.06	13611.51	{ -0.01
7400.72	12	2		13508.48		+0.06	+0.06
7398.97	3			13511.67	-0.03	13615.03	+0.02
7398.137	12	2		13513.19		13616.50	
7396.99	15	2		13515.29	-0.02	7	-0.02
7392.86	4			13522.84	-0.03	13621.54	+0.03
7390.729	400Z	60		13526.74	+0.01	13624.07	+0.03
7388.86	4			13530.16	-0.05		
7385.35	3			13536.59	+0.05	13629.73	+0.04
7384.75	1			13537.69	+0.09		
7384.03	10			13539.01	-0.01	13630.01	+0.03
7381.77	1			13543.16	-0.01	13644.07	+0.04
7378.91	2			13548.41	+0.03	13649.74	-0.02
7377.176	8	1		13551.59	+0.05	13651.04	0.00
7376.987	4			13551.94	0.00	13652.01	256.34 ₂ ⁸ —39286 ₁
7375.59	1			13554.50	-0.02	13654.10	5638 ₂ —19292 ₃
7374.389	1.5			13556.71	+0.02	13657.33	4567 ₄ —18224 ₁
7368.160	30	6		13568.17	+0.04	13663.15	26463 ₁ ⁸ —40130 ₂
7365.35	100	20		13573.35	+0.02	13666.31	+0.01
						13677.28	27533 ₂ ⁸ —41211 ₂
						13688.05	20908 ₂ —34596 ₁
						13692.92	27074 ₄ —40767 ₃
						13697.13	28583 ₃ ⁸ —42233 ₄
						13699.87	
						13700.37	
						13704.28	
						13705.54	0.00
						13706.07	{ +0.04
						13713.40	{ +0.02
						13713.40	{ -0.01

Appendix B. Observed and Classified Lines of Hf I.—Continued

1	2	3	4	5	6	Intensity		Intensity		Wave number cm ⁻¹		Classification
						Tube	Spark	Tube	Spark	Wavelength air (Å)	Wavelength air (Å)	
7288.31	1			13716.82	0.00	36075 ₄ ^a —49791 ₃	7221.86	8	1	13843.03	+0.01	14740 ₂ ^a —28583 ₃
7287.79	1			13717.80	+0.03	34877 ₃ ^a —48594 ₂	7221.20	2		13844.30	-0.01	28267 ₂ ^a —42111 ₁
7285.58	1			13721.96	+0.01	34877 ₃ ^a —48598 ₃	7220.76	7	1	13845.14	0.00	33121 ₂ ^a —46966 ₃
7285.12	2			13722.83	-0.02	33157 ₁ ^a —46860 ₂	7216.53	12	1	13853.26	+0.01	33159 ₃ ^a —46992 ₄
7283.43	1			13726.01			7212.882	2		13860.26	-0.02	36419 ₃ ^a —50279 ₅
7282.29	3			13728.16	+0.03	15673 ₃ ^a —29401 ₂	7206.31	1		13872.90	+0.11	33994 ₂ ^a —47867 ₂
7282.01	1			13728.69			7205.08	30	5	13875.27	0.00	28200 ₂ ^a —42075 ₂
7281.52	30			13729.61	-0.01	22830 ₃ ^a —36609 ₃	7204.634	4		13876.04	+0.08	22199 ₃ ^a —36075 ₄
7280.006	10			13732.47	+0.03	27149 ₂ ^a —40382 ₃	7200.91	12	1	13883.31		
7277.90	15			13736.44	0.00	29732 ₂ ^a —43489 ₃	7196.09	20	5	13892.61	0.00	22880 ₃ ^a —36772 ₂
7277.07	5			13738.01			7191.21	3		13902.03	-0.01	33994 ₂ ^a —47896 ₃
7273.28	7	1		13745.17			7189.99	1		13904.39	-0.02	32533 ₃ ^a —46437 ₂
7272.93	1			13745.83	+0.02	31575 ₄ ^a —45324 ₄	7188.84	3		13906.62		
7272.33	1			13746.96	-0.01	32533 ₃ ^a —46280 ₃	7185.985	40	6	13912.14	{+0.04 0.00}	25281 ₃ ^a —39193 ₃
7271.24	2			13749.02	-0.02	32533 ₃ ^a —46282 ₄	7182.94	3		13918.04		25634 ₂ ^a —39546 ₁
7263.04	15	2		13764.55	-0.07	275333 ₁ ^a —41293 ₂	7181.148	6	1	13921.51	+0.01	34947 ₂ ^a —48869 ₃
7262.587	80Z	10		13765.41	-0.01	14435 ₂ ^a —28200 ₂	7179.20	3		13925.29		
7261.82	4			13766.86	+0.01	33538 ₂ ^a —47304 ₂	7177.12	8	1	13929.33	-0.01	28790 ^f ₁ —42719 ₂
7257.99	5			13774.12	-0.01	28527 ₁ ^a —42302 ₃	7175.94	1		13931.62	+0.01	37269 ₄ ^a —51201 ₄
7255.43	5	1		13778.98			7167.42	10	2	13948.18	-0.03	18143 ₁ ^a —32091 ₁
7251.80	2			13785.88	-0.11	26918 ₁ ^a —40704 ₁	7163.58	1		13955.65	0.00	14092 ₁ ^a —28047 ₁
7251.66	5			13786.15								34596 ₁ ^a —48552 ₂
7244.11	40			13800.52	-0.01	30977 ₃ ^a —44777 ₄	7163.48	3		13955.85	{-0.02 -0.05}	36237 ₃ ^a —50193 ₂
7240.87	5000Z	600		13806.69	+0.02	2356 ₃ ^a —16163 ₂	7162.643	7	1	13957.48	-0.03	28527 ₁ ^a —42485 ₁
7237.101	8000Z	1000		13813.88	+0.02	4567 ₄ ^a —18381 ₃	7161.64	2		13959.43	-0.01	27516 ₃ ^a —41475 ₃
7233.10	15	2		13821.52	{+0.04 +0.01}	18270 ₆ ^a —32091 ₁	7161.19	1		13960.31	{-0.03 -0.02}	34991 ₁ ^a —48951 ₂
7231.565	30	4		13824.46	+0.01	27654 ₃ ^a —41475 ₃						33994 ₂ ^a —47955 ₂
7225.15	1			13836.73	+0.04	26305 ₃ ^a —40130 ₂						
7223.01	1			13840.83	+0.02	35115 ₂ ^a —48951 ₂						
7222.64	20	3		13841.54	+0.03	26523 ₃ ^a —50364 ₂						
						29963 ₃ ^a —43838 ₄						

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6	
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Classification		Wave- length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	
	Tube	Spark					Tube	Spark				
7157.945	30	4	13966.64	+0.01	16766 ₁ —30733 ₃	7065.83	12	2	14148.72	0.00	27149 ₂ ^a —41298 ₂	
7156.93	1	2	13968.62	+0.01	20908 ₂ —34877 ₃	7064.34	15?	30?	14151.70	0.00	5638 ₂ ^a —19791 ₂	
7156.31	10	1	13969.83	+0.03	22880 ₃ —36850 ₄	7063.852	3000Z	400	14152.68	0.00	25634 ₂ ^a —39788 ₂	
7153.21	6	1	13975.89	{+0.02 -0.09}	28790 ₁ —42782 ₁	7062.85	150	20	14154.69	{-0.01 -0.01}	(26463 ₁ ^a —40618 ₁)	
7144.81	4		13992.32	{+0.02 -0.09}	34877 ₃ —48869 ₃	7061.90	80	10	14156.59	-0.02	27018 ₅ ^a —41175 ₄	
7131.82	7000Z	1000	14017.80	-0.01	0 ₂ —14017 ₁ ^a	7055.38	5		14169.67	+0.07	35453 ₃ ^a —49623 ₄	
7120.80	30	5	14039.50	-0.02	20908 ₂ —34947 ₂	7054.515	4		14171.41	0.00	33137 ₁ ^a —47309 ₁	
7119.520	700Z	100	14042.02	-0.01	17901 ₅ ^a —31943 ₁	7054.052	40		14172.34	-0.01	26463 ₁ ^a —40636 ₂	
7118.37	30	5	14044.29	-0.01	30733 ₄ ^a —44777 ₄	7052.65	50	6	14175.16	+0.02	14092 ₁ ^a —28267 ₂	
7115.685	40	7	14049.59	{+0.02 -0.01}	14740 ₂ —28790 ₁ ^a	7050.11	1		14180.27			
					26463 ₁ ^a —40513 ₂							
7114.85	3		14051.24	-0.06	31943 ₁ ^a —45994 ₃	7049.72	6		14181.05			
7114.46	2		14052.01	-0.04	26715 ₃ ^a —40767 ₃	7048.885	12	1	14182.73	0.00	14017 ₁ ^a —28200 ₂	
7105.28	2		14070.16		14070.16	7046.35	2		14187.83	+0.01	33121 ₁ ^a —47309 ₁	
7100.546	150	20	14079.54	+0.01	15673 ₃ ^a —29752 ₂	7042.69	3		14195.21	+0.09	28200 ₂ ^a —42395 ₃	
7096.712	12	1	14087.15	+0.02	28533 ₃ ^a —42670 ₄	7040.54	1		14199.54	+0.08	34805 ₄ ^a —49005 ₄	
7096.36	15	2	14087.85	+0.01	29401 ₂ ^a —43489 ₃	7039.16	12	1	14202.32	+0.02	36075 ₄ ^a —50279 ₃	
7096.15	5		14088.26		14088.26	7038.07	2		14204.52	{-0.02	33139 ₃ ^a —47345 ₃	
7094.412	100Z	15	14091.72	+0.02	25194 ₁ ^a —39286 ₁	7036.95	5		14206.78	{+0.04	35453 ₃ ^a —49660 ₃	
7093.83	50	6	14092.87	+0.01	14435 ₂ ^a —28527 ₁	7036.48	2		14207.73	-0.02	26305 ₃ ^a —40513 ₂	
7089.81	7		14100.86	0.00	27074 ₄ ^a —41175 ₄ ^a	7035.15	70	10	14210.42	+0.02	16766 ₄ ^a —30977 ₃	
7086.71	6		14107.03	-0.05	37301 ₆ ^a —51408 ₅	7032.55	12	1	14215.67	0.00	26918 ₁ ^a —41133 ₆	
7085.33	6		14109.78	+0.02	25084 ₂ ^a —39193 ₃	7028.93	3		14222.99	0.00	27516 ₄ ^a —41739 ₃	
7085.02	2		14110.40		14111.21	7028.52	1		14223.82			
7084.61	4		14111.21	+0.04	30146 ₂ ^a —44257 ₁ ^a	7028.24	1		14224.39	-0.06	33121 ₂ ^a —47345 ₃	
7083.016	6		14114.39	+0.01	34877 ₃ ^a —48991 ₂	7026.24	1		14228.44	+0.03	31619 ₂ ^a —45848 ₂	
7081.28	1		14117.85	+0.04	31610 ₃ ^a —45728 ₂	7019.25	50	10	14242.61	-0.03	29246 ₄ ^a —43489 ₃	
7075.34	1		14129.70		14129.70	7018.22	3		14244.70			
7074.76	2		14130.86		14130.86	7014.29	20	2	14252.68	-0.01	10532 ₄ ^a —24785 ₄	
7071.01	2		14138.35		14138.35	7010.69	30	4	14260.00	-0.03	25444 ₀ ^a —39704 ₁	
7070.77	6	1	14138.83	0.00		7007.36	2		14266.78	-0.07	31054 ₃ ^a —45321 ₄	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Classification	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
							Tube	Spark				
7002.94	10	1	14275.78	-0.03	26918 ₁ —41193 ₁	6884.53	10	1	14521.31	+0.02	27654 ₃ —42175 ₄	
6982.75	1		14317.06	-0.05	30146 ₂ —44463 ₃	6874.89	40Z	5	14541.68	+0.02	0 ₂ —14541 ₃	
6981.61	50	8	14319.39	-0.01	24966 ₀ —39286 ₁	6869.32	1		14553.47	-0.03	43561 ₁ —58115 ₂	
6979.61	100Z	20	14323.50	0.00	15673 ₃ —29996 ₃	6865.96	1		14560.59		39286 ₁ —53853 ₆	
6978.30	1		14326.19	-0.01	27149 ₂ —41475 ₃	6862.77	1		14567.36	-0.07		
6976.20	20	2	14330.50	0.00	26305 ₃ —40636 ₂	6861.26	1		14570.56	-0.06	31610 ₂ —46181 ₃	
6973.03	1		14337.01	+0.03	31943 ₄ —46280 ₃	6860.45	4		14572.28	0.00	31610 ₂ —46183 ₂	
6972.53	2		14338.04	0.00	35453 ₃ —49791 ₃	6858.76	200Z		14575.87	-0.03	16766 ₄ —31342 ₃	
6972.03	4		14339.07	+0.02	31943 ₄ —46282 ₄	6858.56	60	40	14576.30	0.00	26305 ₃ —40882 ₃	
6970.42	50	6	14342.38	-0.02	24785 ₄ —39127 ₃	6857.03	20Z	3	14579.55	-0.01	24966 ₀ —39546 ₁	
6967.71	1		14347.96	+0.02	27074 ₄ —41422 ₃	6853.01	2		14588.10			
6965.809	40	5	14351.88	+0.02	25194 ₁ —39546 ₁	6852.906	10	1	14588.32	+0.02	22450 ₂ —37038 ₂	
6962.46	1		14358.78	+0.02	33538 ₂ —47896 ₃	6852.24	3		14589.74	-0.01	27149 ₂ —41739 ₃	
6956.80	3		14370.46	-0.03	37269 ₄ —51640 ₄	6851.314	9		14591.71	+0.03	29246 ₁ —43858 ₄	
6954.17	20	2	14375.90	+0.01	20908 ₂ —35284 ₁	6850.06	60Z	8	14594.39	-0.03	25194 ₁ —39788 ₂	
6952.849	12	1	14378.63	+0.01	29996 ₃ —44375 ₂	6849.57	1		14595.43			
6949.24	1		14386.09	-0.02	31342 ₃ —45728 ₂	6849.22	10		14596.18	-0.03	25194 ₁ —39790 ₁	
6947.53	20	2	14389.64	+0.04	22880 ₃ —37269 ₄	6841.182	9	1	14613.32	-0.01	33137 ₁ —47751 ₀	
6938.85	1		14407.64	0.00	33949 ₃ —48356 ₄	6839.378	1		14617.18			
6937.456	7	1	14410.53	+0.02	30977 ₃ —45387 ₄	6837.95	4		14620.23	-0.01	25084 ₂ —39704 ₁	
6936.57	3		14412.37	-0.02	33994 ₂ —48407 ₂	6836.83	1		14622.63	+0.04	29752 ₂ —44375 ₂	
6928.15	2		14429.89		28583 ₃ —43016 ₂	6834.18	1		14628.30	-0.05	37301 ₆ —51929 ₅	
6926.780	15		14432.74	-0.03	14092 ₁ —28526 ₆	6833.750	20	2	14629.22	+0.01	27654 ₃ —42228 ₄	
6926.21	70Z	10	14433.93	-0.01	28267 ₂ —42719 ₂	6832.62	3h		14631.64	+0.03	30733 ₄ —45364 ₃	
6917.48	4		14452.14	-0.04		6826.55	100Z	10	14644.65	0.00	23644 ₃ —38289 ₂	
6914.17	5		14459.06	0.00	32533 ₃ —46992 ₄	6824.34	3		14649.39	+0.01	25194 ₁ —39843 ₀	
6911.40	300Z	80	14464.86	0.00	8983 ₂ —23448 ₃	6822.06	4		14654.29	+0.01	30733 ₄ —45387 ₄	
6902.78	12	1	14482.92		6818.95	2000Z		300	14660.97	-0.03	8983 ₂ —23644 ₃	
6896.52	15	2	14496.07	+0.04	25634 ₂ —40130 ₂	6814.96	5		14669.55	+0.06	31610 ₂ —46280 ₃	
6889.81	10	1	14510.19	+0.02	14017 ₁ —28527 ₁	6805.313	3		14690.35			

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
6801.771	7	1	14698.00	+0.02	14092 ₁ —28790 ₁ ^a	6736.42	1		14840.58	0.00	31342 ₂ —46183 ₂
6798.481	1		14705.11		27654 ₃ —42360 ₃	6734.65	2		14844.48	0.00	27516 ₄ —42360 ₃
6797.810	3		14706.56	+0.01	26715 ₃ —41422 ₃	6723.51	3		14869.08	-0.03	33538 ₃ —48407 ₃
6797.56	2		14707.10	+0.04		6720.95	2		14874.74	0.00	33994 ₄ —48869 ₃
6793.99	10		14714.83			6718.87	2		14879.35	+0.02	25634 ₂ —40513 ₂
6789.28					4567 ₄ —19292 ₃	6717.19	3		14883.07	0.00	33139 ₃ —48022 ₄
6786.40	1		14725.04	0.00		6716.014	30Z	3	14885.67	+0.01	22450 ₃ —37336 ₁
6782.66	1		14731.29		35453 ₃ —50193 ₂	6713.48	200Z	20	14891.29	0.00	16163 ₂ —31054 ₃
6778.24	1		14739.41	-0.01	28267 ₂ —43016 ₂	6708.33	20Z	3	14902.73	+0.02	24085 ₅ —38987 ₄
6774.36	4		14749.02	-0.04		6707.662	2		14904.21	+0.05	28200 ₂ —43104 ₃
6774.22	2		14757.77	0.00	33139 ₃ —47896 ₃	6707.200	4		14905.24	0.00	26305 ₃ —41211 ₂
6773.63	3h		14759.06	-0.10	33949 ₃ —48708 ₂	6707.032	1		14905.61	+0.01	28583 ₃ —43489 ₃
6773.06	30Z		14760.30	-0.01	24085 ₅ —38845 ₅	6705.740	1		14908.48	-0.01	31952 ₁ —46860 ₂
6770.87	2h		14765.08			6705.23	4		14909.62		
6769.924	40Z		14767.14	0.00	27516 ₄ —42283 ₄	6704.926	4		14910.29	-0.02	33139 ₃ —48049 ₃
6767.88	5		14771.60	{+0.07 -0.07}	28790 ₁ —43561 ₁	6704.33	2		14911.62	+0.06	33994 ₂ —48906 ₂
6767.27	20	2	14772.93	-0.01	32533 ₃ —47304 ₂	6704.17	2		14911.97	+0.01	27149 ₂ —42061 ₃
6763.705	9	1	14780.72	+0.01	10508 ₂ —25281 ₃	6702.90	3		14914.80	-0.02	34877 ₃ —49791 ₃
6763.03	1		14782.19	0.00	29996 ₃ —44777 ₄	6702.30	1		14916.13	0.00	30733 ₄ —45649 ₃
6762.42	4		14783.53	+0.01	36419 ₃ —51201 ₄	6698.45	2		14924.71		
6756.16	2		14797.22	-0.01	34877 ₃ —49660 ₃	6704.33	2		14934.05		
6749.15	1		14812.59	-0.02	28790 ₁ —43561 ₁	6693.491	15Z	1	14935.76	+0.01	25194 ₂ —40130 ₂
6747.56	1		14816.08	+0.02	32533 ₃ —47345 ₃	6691.66	20	2	14939.85	-0.01	31342 ₃ —46282 ₄
6747.16	1		14816.96	0.00	33139 ₃ —47955 ₂	6684.50	30Z	2	14955.85	0.00	16163 ₂ —31119 ₂
6747.00	2		14817.31	+0.01	33121 ₂ —47938 ₃	6678.82	6	1	14968.57	+0.02	28047 ₁ —43016 ₂
6745.61	1		14820.37		33949 ₃ —48746 ₃	6676.39	5		14974.02	+0.03	2940I ₂ —44375 ₂
6744.00	7Z		14823.90	-0.01	24966 ₆ —39790 ₁	6671.28	20Z	2	14985.49	-0.01	25281 ₃ —40267 ₂
6742.64	1		14826.89	-0.04	31610 ₂ —46437 ₂	6669.47	1		14987.31	0.00	33994 ₂ —48982 ₁
6739.210	9	1	14834.44	+0.01	26463 ₁ —41298 ₂	6669.49	2		14988.43		36419 ₃ —51408 ₅
6737.15	1		14838.98	{+0.06 +0.02}	31342 ₃ —46181 ₃	6669.49	2		14989.51	+0.10	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Classification	Classification				
Wavelength air (Å)	Intensity			Wave- length air (Å)	Wavelength air (Å)	Intensity	Wave number cm ⁻¹				
	Tube	Spark				Tube	Spark				
6669.34	15Z	2	14989.85	+0.01 {+0.07 {-0.03	28527 ₁ —43517 ₂ 30146 ₂ —45138 ₂ 26305 ₃ —41298 ₂	6596.90 6596.64 6595.491 6595.188 6591.80	2 6 8 2 30	15154.45 15155.01 15157.69 15158.38 15166.17	+0.03 +0.02 +0.01 -0.01 +0.01	27516 ₄ —42670 ₄ 23222 ₄ —38407 ₃ 26918 ₁ —42075 ₂ 36237 ₃ —51395 ₃ 6572 ₁ —21738 ₁	
6668.14	4h		14992.55	+0.01 {-0.03	33994 ₂ —48991 ₂						
6667.89	3hl		14993.11	+0.01	23327 ₂ —38325 ₂						
6666.35	10		14996.57	+0.01 -0.03	15000.42 15002.09	+0.01 +0.01 +0.02 0.00 -0.01	32091 ₁ —47092 ₁ 25634 ₂ —40636 ₂ 31952 ₁ —46961 ₂ 14740 ₂ —29752 ₂ 27654 ₃ —42670 ₄	8 1 10 15 8	15168.55 15169.07 15170.06 15176.70 15180.01	0.00 {+0.01 {-0.03 0.00 +0.02	31943 ₂ —47112 ₃ 31943 ₄ —47112 ₃ 32533 ₃ —47702 ₂ 26305 ₃ —41475 ₃ 16766 ₄ —31945 ₄ 33139 ₃ —48319 ₃
6665.839	1		14997.72		6590.767	8	1	15168.55	0.00		
6664.64	1		15000.42	+0.01	6590.54	1	15169.07				
6663.90	2		15002.09	+0.01	6590.111	10	1	15170.06	0.00		
6660.507	1		15009.73	+0.02	6587.23	150Z	15	15176.70	-0.01		
6659.42	40Z	4	15012.18	0.00	6585.794	8		15180.01	+0.02		
6657.51	9		15016.48	-0.01							
6656.76	1		15018.18	+0.04	31943 ₃ —46961 ₂	6584.42	2	15183.17	+0.01		
6654.52	1		15023.23	-0.08	31943 ₄ —46966 ₃	6583.26	3	15185.85	+0.01		
6649.05	2		15035.59	+0.02	28526 ₆ —43561 ₁	6582.14	1	15188.43	+0.03		
6646.15	1		15042.15	+0.01	33949 ₃ —48991 ₂	6578.138	4	15197.67	+0.03		
6643.085	9		15049.09	+0.02	31943 ₄ —46992 ₄	6576.964	4	15200.39	+0.04		
6641.21	2		15053.34	+0.05	26715 ₃ —41768 ₂	6573.78	2	15207.75	+0.03		
6639.97	2		15056.15	+0.07	33949 ₃ —49005 ₄	6573.48	1	15208.44	+0.07		
6633.52	1		15070.79	+0.03	22199 ₃ —37269 ₄	6572.27	5	15211.24	0.00		
6632.59	2		15072.90	-0.01	32533 ₃ —47606 ₄	6568.02	3	15221.08	+0.01		
6628.767	6		15081.60	-0.01	33139 ₃ —48220 ₄	6567.67	20	15221.90	+0.01		
6627.91	2		15083.55	+0.05	26715 ₃ —41768 ₂	6557.59	2	15245.29	0.00		
6626.62	3		15086.48	0.00	6556.48	70Z	6	15247.87	-0.01		
6625.57	4		15088.87	+0.05	6552.91	20Z	2	15256.18	+0.03		
6624.35	1		15091.65		6550.68	9		15261.37	-0.01		
6622.76	2		15095.28	+0.05	31342 ₃ —46437 ₂	6549.35	1	15264.47			
6621.13	1		15098.99	-0.02	31119 ₂ —46218 ₃	6541.58	2	15282.60			
6616.66	4		15109.19	-0.01	26715 ₃ —41824 ₃	6540.24	2	15285.74	-0.03		
6616.18	5		15110.29	0.00	25084 ₂ —40194 ₂	6536.56	15Z	15294.34	-0.03		
6612.68	2		15118.29	+0.02	26918 ₁ —42036 ₁	6534.09	4	15300.12	-0.02		
6611.02	1		15122.08	-0.01	34877 ₃ —49999 ₃	6531.86	10	15305.35	-0.01		

1	2		3		4		5		6	
	Intensity		Wave number cm ⁻¹		Wave number o-c cm ⁻¹		Classification			
Wave-length air (Å)	Tube	Spark					Wavelength air (Å)		Intensity	
6530.23	3		15309.17	-0.02	14092 ₁ -2940 ₁ ₂	6479.486	7		15429.06	
6527.05	1		15316.63	-0.01	28527 ₁ -4384 ₄ ₁	6478.72	1		15430.88	+0.02
6526.77	9		15317.28	0.00	28200 ₂ -4351 ₇ ₂	6477.03	4		15434.91	-0.04
6526.03	3		15319.02	-0.03	25194 ₁ -4051 ₃ ₂	6475.04	1		15439.65	
6525.66	1		15319.89	-0.06	33139 ₃ -48459 ₂	6474.14	4		15441.80	0.00
6525.330	2		15320.66	-0.03	36075 ₄ -51395 ₃	6472.67	6		15445.31	+0.09
6525.13	2		15321.13	{ -0.03 -0.06	27074 ₄ -42395 ₃ 33137 ₁ -48459 ₂	6472.14	1		15446.57	
6523.92	30Z	2	15323.97	-0.03	19791 ₂ -35115 ₂	6469.324	3		15453.30	+0.02
6521.82	2		15328.91	0.00	20908 ₂ -36237 ₃	6468.32	4		15455.69	+0.01
6521.175	15	1	15330.42	-0.03	29752 ₂ -45083 ₃	6467.931	8		15456.62	0.00
6519.82	1		15333.61	-0.02	36075 ₄ -51408 ₃	6466.59	1		15459.83	-0.03
6518.14	1		15337.56	-0.04	33121 ₂ -48459 ₂	6461.49	1		15472.03	-0.01
6512.37	3		15351.15	-0.01	31610 ₂ -46961 ₂	6456.956	50Z		15482.90	0.00
6511.81	3h		15352.47	+0.03	33994 ₃ -49347 ₃	6454.466	3		15488.87	-0.01
6510.388	6		15355.83	+0.01	31610 ₂ -46966 ₃	6451.16	1		15496.81	+0.06
6508.12	5		15361.18	{ -0.04 +0.01	31619 ₂ -46981 ₂ 31943 ₃ -47304 ₂	6449.52	2		15500.75	
6507.12	4		15363.54	-0.04	32553 ₃ -47396 ₃	6447.10	1		15501.60	+0.03
6505.22	1		15368.02	0.00	29996 ₃ -45364 ₃	6444.07	5		15506.56	
6505.12	1		15368.26	-0.02	35538 ₂ -48906 ₂	6443.11	1		15513.86	
6501.85	1		15375.99	+0.05	30146 ₂ -45522 ₃	6442.22			15516.17	{ +0.05 0.00
6500.49	4		15379.21	+0.01	27074 ₄ -42453 ₄	6442.22	1		15518.31	+0.07
6498.46	1		15384.01	+0.03	26918 ₁ -42302 ₂	6439.03	1		15526.00	
6495.64	1		15390.69	0.00	29996 ₃ -45387 ₄	6438.36	1		15527.61	+0.05
6492.54	5		15398.04	+0.02	33949 ₃ -49347 ₃	6436.99	6		15530.92	{ +0.04 -0.06
6490.61	2		15402.62	0.00	31943 ₁ -47345 ₃	6435.60	1		15534.27	+0.05
6486.32	1		15412.80						15542 ₃ -46360 ₂	
6485.43	3		15414.92	-0.02					22880 ₃ -38407 ₃	
6483.32	1		15419.94						29246 ₄ -44777 ₄	
6482.526	3		15421.82	-0.05					26922 ₄ -42453 ₄	
6481.55	4		15424.15	0.00					36237 ₃ -51171 ₂	

33139₃-48598₃
 31619₂-47092₂
 23644₃-39127₃
 32533₃-48922₄
 34877₃-50393₄

33538₂-48991₂
 33139₃-48594₂
 16163₂-31619₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
6434.77	4		15536.28			6373.46	1		15685.73		
6434.52	2		15536.88	+0.02	35284 ₁ —50828 ₁	6372.792	2		15687.37	-0.05	32533 ₃ —48220 ₄
6431.46	1		15544.27	+0.05	33994 ₄ —49540 ₅	6371.36	4		15690.90	+0.01	31610 ₂ —47304 ₂
6430.75	5		15545.99	+0.03	30733 ₃ —46282 ₄	6370.018	10	1	15694.20	-0.01	20908 ₂ —36609 ₃
6429.44	10Z		15549.16			6367.09	3		15701.42		
6423.40	5		15563.78	+0.04	20960 ₄ —36523 ₃	6366.87	1		15701.96	-0.02	30146 ₂ —45848 ₂
6422.76	1		15565.33	+0.04	36075 ₄ —51640 ₄	6363.08	1		15711.32	{+0.04 +0.04}	14435 ₂ —30146 ₂
6421.91	2		15567.39	+0.03	26918 ₁ —42485 ₁	6359.4	10	1	15719.32	{+0.04 +0.04}	33949 ₃ —49660 ₃
6421.10	6		15569.35	+0.04	33139 ₃ —48708 ₂	6357.47	1		15725.18	+0.05	31619 ₂ —47345 ₂
6420.36	1		15569.93	-0.01	27149 ₂ —42719 ₂	6355.99	1		15728.84		
6420.58	1		15570.61	+0.06	33137 ₁ —48708 ₂	6355.68	4		15729.61	+0.02	28527 ₁ —44257 ₁
6418.02	10Z		15576.82	0.00	25634 ₂ —41211 ₂	6355.393	5		15730.32	0.00	33139 ₃ —48869 ₃
6409.50	70Z		15597.53	+0.03	21738 ₁ —37336 ₁	6354.30	1		15733.02		
6406.53	15		15604.76	+0.02	14541 ₃ —30146 ₂	6353.46	3		15735.10	{+0.06 -0.03}	23252 ₄ —38987 ₄
6400.24	2		15620.10	+0.14	25084 ₂ —40704 _{1?}	6349.91	4		15743.90	+0.07	31610 ₂ —47345 ₃
6398.94	1		15623.27								25678 ₃ —41422 ₃
6397.91	1		15625.78								
6396.67	1		15628.81	+0.10	33994 ₄ —49623 ₄	6347.63	5		15749.56	-0.01	25444 ₀ —41193 ₁
6390.40	2		15644.15	+0.07	28200 ₂ —43844 ₁	6347.37	2		15750.20	+0.03	31952 ₁ —47702 ₂
6390.22	10		15644.59			6347.10	8		15750.87	+0.07	26305 ₃ —42061 ₃
6388.914	20Z	2	15647.79	+0.01	26463 ₁ —42111 ₁	6345.08	3		15755.89	+0.07	31943 ₂ —47702 ₂
6386.229	300Z	40	15654.37	+0.01	2356 ₃ —18011 ₂	6343.98	2		15758.62	+0.02	
6383.69	20	1	15660.59	0.00	14092 ₁ —29752 ₂	6340.708	15		15766.75		
6382.232	10		15664.17	+0.01	25634 ₂ —41298 ₂	6340.48	3		15767.91		
6381.564	10		15665.81	-0.04	33994 ₄ —49660 ₃	6340.24	3		15773.25	+0.02	
6380.196	80Z	7	15669.17	-0.01	15673 ₃ —31342 ₃	6330.66	3		15791.77	+0.02	
6377.53	3		15675.72	+0.01	25281 ₃ —40957 ₂						
6376.88	1		15677.32								
6376.19	20Z	2	15679.01	-0.03	23448 ₃ —39127 ₃	6328.76	1		15796.52	+0.02	27074 ₄ —42874 ₄
6375.03	1		15681.87	+0.02	29401 ₂ —45083 ₃	6228.51	3		15797.14	-0.01	33994 ₄ —49791 ₂
						6323.69	1		15809.18	+0.02	33538 ₂ —49347 ₃
						6318.313	30Z	3	15822.63	+0.02	19292 ₃ —35115 ₂
						6313.41	30	2	15834.92	-0.04	27654 ₃ —43489 ₃

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
6312.72	3	7	15838.65	0.00	29246 ^a —45083 ²	6266.63	1		15953.13	+0.05	31943 ^b —47896 ₃
6311.844	50Z	1	15838.85	0.00	22450 ³ —38289 ²	6262.94	3		15962.53	+0.04	31342 ³ —47304 ₂
6310.74	10		15841.62	-0.02	25634 ² —41475 ₃	6262.71	1		15963.11		26202 ⁵ —42175 ₄
6309.67	1		15844.31	+0.03	33137 ¹ —48982 ₁	6258.79	40Z	4	15973.11	+0.02	26305 ³ —42283 ₄
6307.91	1.		15848.73	+0.02	28200 ₂ —44049 ₃	6256.97	70Z	9	15977.76	0.00	
6306.50	2		15852.27	{ +0.02 -0.02	27018 ₅ —42877 ₄	6252.92	1		15988.11	+0.13	20784 ₁ —36772 ₂
6306.00	3		15853.53	{ +0.06 0.00	33139 ₃ —48991 ₂	6250.36	2		15994.65	+0.03	31943 ₂ —47938 ₃
6304.31	1		15857.78		29401 ₂ —45254 ₂	6250.16	1		15995.17	+0.04	31943 ₄ —47938 ₃
6303.90	1		15858.81		33137 ₁ —48991 ₂	6243.83	1		16011.38	+0.01	31943 ₂ —47955 ₂
6303.16	2		15860.67	-0.02	6242.27	7			16015.38	0.00	30977 ₃ —46992 ₄
6302.63	1		15862.01	+0.02	33121 ₂ —48982 ₄	6241.81	10Z	1	16016.56	+0.02	25194 ₄ —41211 ₂
6300.94	2		15866.26	{ +0.05 +0.03	31119 ₂ —46981 ₂	6238.59	100Z	10	16024.83	+0.01	2356 ₃ —18381 ₃
6300.72	8		15866.81	-0.01	23327 ₂ —39193 ₃	6237.34	3		16028.04	+0.01	27533 ₁ —43561 ₁
6300.128	20		15868.30	+0.01	33139 ₃ —49005 ₄	6236.51	8	2	16030.17	-0.03	27074 ₄ —43104 ₃
6299.99	8		15868.65	-0.03	27149 ₂ —43016 ₂	6229.10	15	1	16049.24		
6299.52	50Z		15869.84	0.00	2356 ₃ —18224 ₄	6227.03	2		16054.58	+0.04	35453 ₃ —51508 ₂
6298.63	1		15872.08		29401 ₂ —45270 ₁	6224.35	2		16061.49	0.00	32533 ₃ —48594 ₂
6298.12	3		15873.36	-0.01	6223.74	1			16063.07		
6297.903	4		15473.91	-0.02	26305 ₃ —42175 ₄	6219.83	1		16073.16	0.00	29401 ₂ —45474 ₁
6296.27	5		15878.03	+0.03	15872.08	6216.800	80Z	10	16081.00	-0.01	26202 ₃ —42283 ₄
6290.10	1		15893.60	+0.06	25084 ₂ —40957 ₂	6212.71	1		16091.58	-0.04	31610 ₂ —47702 ₂
6278.804	4		15922.20	+0.03	32533 ₃ —48407 ₂	6212.00	20Z	2	16093.42	-0.01	17901 ₅ —33994 ₄
6278.40	1		15923.22		6572 ₁ —22450 ₂	6211.70	3		16094.20		
6277.197	10Z	1	15926.27		25281 ₃ —41175 ₄	6211.60	4		16094.46		
6276.41	3		15928.27	+0.02	31952 ₁ —47874 ₄	6210.680	150Z	20	16096.84	0.00	24785 ₄ —40882 ₃
6275.49	15		15930.60	0.00	6209.43	40Z	4		16100.08	-0.01	5638 ₂ —21738 ₁
6273.25	1		15936.29	+0.08	16163 ₂ —32091 ₁	6207.97	10	1	16103.87	-0.01	25194 ₄ —41298 ₂
6272.770	9		15937.51	+0.03	31943 ₂ —47874 ₁	6207.46	10	1	16105.19	0.00	25634 ₂ —41739 ₃
6271.355	15Z	2	15941.11	0.00	35993 ₅ —51929 ₅	6206.51	12		16106.18	+0.05	31943 ₄ —48049 ₃
6270.44			15943.43	+0.04	15673 ₃ —31610 ₂				16107.66	+0.05	22880 ₃ —38987 ₄

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Classification	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
							Tube	Spark				
6206.36	10	16108.05	+0.01	28267 ₂ —44375 ₂	6138.51	1	16286.09	—0.01	31610 ₂ —47896 ₃			
6200.890	4	16122.26	—0.01	14017 ₁ —30146 ₂	6135.40	10	16294.35					
6198.460	20Z	16128.58	+0.08	25281 ₃ —41422 ₃	6129.49	1	16310.06					
6193.806	4	16140.70	+0.01	23644 ₃ —39738 ₂	6129.19	1	16310.86					
6192.475	50Z	16144.16	+0.01		6128.14	3	16313.65	—0.03	22880 ₃ —39193 ₃			
6191.784	10	16145.97	0.00	25678 ₃ —41824 ₃	6126.30	6	16318.55	—0.06	26463 ₁ —42782 ₁			
6191.33	1	16147.15	+0.07	41475 ₃ —57622 ₃	6122.93	3	16327.53	0.00	28647 ₁ —44375 ₂			
6185.128	400Z	16163.34	—0.01	0 ₂ —16163 ₂	6122.00	15	16330.01	—0.02	27231 ₀ —43561 ₁			
6176.99	2	16184.64	+0.04	29996 ₃ —46181 ₃	6119.70	5	16336.15	+0.02	32533 ₃ —48869 ₃			
6176.55	3	16185.79	+0.03	31943 ₂ —48129 ₁	6119.27	2	16337.30					
6172.74	1	16195.78			6118.16	40Z	6	16340.26	—0.04	23448 ₃ —39788 ₂		
6168.66	20Z	16206.49	—0.01	10508 ₂ —26715 ₃	6116.62	5	16344.37	—0.02	31610 ₂ —47955 ₂			
6168.03	3	16208.15	—0.02	33139 ₃ —49347 ₃	6115.29	3	16347.93	0.00	29752 ₂ —46100 ₁			
6167.04	10	16210.75	+0.01	8983 ₂ —25194 ₁	6109.22	1	16364.17					
6166.59	1	16211.93										
6164.70	2	16216.90	—0.03	5521 ₀ —21738 ₁	6108.90	1	16365.03	—0.01	26305 ₃ —42670 ₄			
6152.952	10Z	16247.87	—0.04	2940 ₂ —45649 ₃	6106.22	2	16372.21					
6150.01	3	16255.64	—0.01	26463 ₁ —42719 ₂	6106.11	10	16372.51	—0.02	16766 ₄ —33139 ₃			
6148.68	7	16259.15	0.00	30733 ₄ —46992 ₄	6105.07	3	16375.30	0.00	31943 ₂ —48319 ₃			
6147.24	3	16262.96	—0.01	28200 ₂ —44463 ₃					31943 ₄ —48319 ₃			
6146.99	3	16263.62	0.00	31610 ₂ —47874 ₁	6104.88	15	16375.81	{ 0.00	41739 ₃ —58115 ₂			
6146.54	5	16264.81	{ +0.07	31619 ₂ —47884 ₃	6104.58	20Z	3	{ —0.07	23327 ₂ —39704 ₁			
6144.58	20	16270.00	{ —0.03	33139 ₃ —49403 ₂	6098.63	200Z	30	{ 0.00	4567 ₄ —20960 ₄			
6144.392	30Z	16270.50	0.00	15673 ₃ —31943 ₄	6094.83	4	16392.45	—0.01	29246 ₄ —45649 ₃			
6142.77	1	16274.80			6092.90	2	16408.00					
6142.15	2	16276.44	—0.01	32533 ₃ —48809 ₃	6091.37	20Z	2	16412.12	—0.01	10508 ₂ —26918 ₁		
6141.78	3	16277.42	—0.01	31943 ₄ —48220 ₄					27149 ₂ —43561 ₁			
6140.46	2	16280.92			6090.80	4	16413.66	+0.05	31943 ₄ —48356 ₄			
6139.00	3	16284.79	—0.04	33994 ₄ —50279 ₅	6085.71	3	16427.39	—0.01	25633 ₂ —42061 ₃			
6138.73	1	16285.51	—0.03	29996 ₃ —46282 ₄	6084.67	1	16430.20	—0.03	29752 ₂ —46183 ₂			
					6079.59	1	16443.93	0.00	33949 ₃ —50393 ₄			
					6077.53	2h	16449.50					

1	2	3	4	5	6	1	2	3	4	5	6	
Wavelength air (Å)	Intensity	Tube	Spark	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity	Tube	Spark	Wave number cm ⁻¹	Wave number o-c cm ⁻¹	
6075.50	1			16454.99	-0.01	31952 ₁ ¹ —48407 ₂	6014.90	2		16620.78		
6074.360	10			16458.08	-0.02	32533 ₃ ³ —48991 ₂	6011.843	4		16629.23	0.00	
6073.50	1			16460.41			6007.03	3		16642.55	-0.01	
6071.92	2			16464.70	+0.02	28790 ₁ ¹ —42524 ₂	6004.18	30Z		16650.45	-0.01	
6070.591	8	1	16468.30	+0.01	26202 ₃ ³ —42670 ₄	6002.64	2		16654.72	-0.02	29401 ₃ ³ —46056 ₂	
6070.16	1			16469.47			6002.51	1		16655.08		
6069.20	3			16472.08	+0.04	32533 ₃ ³ —49005 ₄	6002.30	1		16655.67		
6064.712	4			16484.27	-0.02	33139 ₃ ³ —49623 ₄	6000.56	1		16660.50		
6064.257	10	1	16485.50	+0.01	23644 ₃ ³ —40130 ₂	5998.05	3		16667.47		31575 ₄ ⁴ —48236 ₄	
6063.75	2		16486.88	+0.03	25281 ₃ ³ —41768 ₃	5996.99	1		16670.41	+0.03	33121 ₂ ² —49791 ₃	
6059.62	1			16498.12		28583 ₃ ³ —45083 ₃	5996.70	1		16671.22	-0.01	28583 ₃ ³ —45254 ₂
6059.067	4			16499.62	+0.01	14541 ₃ ¹ —31054 ₃	5994.58	10Z		16677.12	+0.02	224510 ₂ ² —39127 ₃
6054.166	80Z	6	16512.98	0.00	{ -0.08	5993.07	5		16681.32	-0.01	29963 ₃ ³ —466678 ₄	
6052.071	4		16518.70	{ +0.01	34877 ₃ ³ —51395 ₃	5992.97	50Z	6	16681.60	-0.03	23448 ₃ ³ —40130 ₂	
6048.86	1		16527.46	+0.02	29752 ₂ ² —46280 ₃	5992.08	3		16684.07	-0.01	14435 ₂ ² —31119 ₂	
6044.61	1			16539.08	0.00	33121 ₂ ² —49660 ₃	5991.97	4		16684.38	+0.01	28790 ₁ ¹ —454474 ₁
6040.37	15Z	1	16550.69	0.00	21738 ₁ ¹ —38289 ₂	5991.806	5		16684.84	-0.04	29752 ₂ ² —46437 ₂	
6039.711	10	1	16552.50	-0.03	26463 ₁ ¹ —43016 ₂	5991.567	4		16685.50	-0.06	33994 ₂ ² —50668 ₃	
6038.82	3		16554.94	-0.01	22880 ₃ ³ —39435 ₂	5989.76	2		16690.54	-0.06	24785 ₄ ⁴ —41475 ₃	
6033.938	2		16568.34	+0.02	31610 ₂ ² —48179 ₂	5986.62	20Z	2	16699.29	-0.04	29401 ₂ ² —46100 ₁	
6030.58	3			16577.56	+0.02	14541 ₃ ¹ —31119 ₂	5986.22	1		16700.41		
6026.14	7		16589.78	-0.05	34805 ₁ ¹ —51395 ₃	5983.381	9	1	16708.33	+0.01	31610 ₂ ² —48319 ₃	
6024.93	2		16593.11	-0.05	29401 ₂ ² —45994 ₃	5981.41	1		16713.84			
6022.54	1		16599.69	0.00	26918 ₁ ¹ —43517 ₂	5981.24	2		16714.31			
6021.77	20Z	2	16601.82	-0.01	14740 ₂ ² —31342 ₃	5980.264	8		16717.04	-0.01	25678 ₃ ³ —42395 ₃	
6019.34	3		16608.52	0.00	31943 ₂ ² —48552 ₂	5978.67						
6018.46	2		16610.95	+0.05	28527 ₁ ¹ —45138 ₂	5974.728	80Z	20	16721.50	-0.02	18270 ₀ ⁰ —34991 ₁	
6017.83	2		16612.69	{ -0.01	30733 ₄ ⁴ —47345 ₃	5974.294	200Z	30	16732.53	-0.02	19791 ₂ ² —36523 ₃	
6016.78	100Z	20	16615.58	-0.04	31342 ₃ ³ —47955 ₂	5971.91	2		16733.74	-0.05	18381 ₃ ³ —35115 ₂	
6015.360	10		16619.51	-0.01	27516 ₄ ⁴ —44132 ₅	5968.37	1		16740.42	0.00	25084 ₂ ² —41824 ₃	
					14435 ₂ ² —31054 ₃				16750.35	+0.04	34805 ₄ ⁴ —51556 ₃	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification	
	Intensity	Tube	Intensity	Spark	Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification	Wavelength air (Å)	Intensity	Wave number cm ⁻¹	Wave number o-c cm ⁻¹	
5966.30	4		16756.16	-0.03	31952 ₁ —48708 ₂	5906.393	8	16926.12	-0.02	31943 ₄ —48866 ₃		
5959.57	5		16775.09	0.00	25678 ₃ —42453 ₄	5906.259	4	16926.50	+0.01	26918 ₁ —43844 ₄		
5959.30	2		16775.85	0.00	27018 ₅ —43794 ₄	5902.95	500Z	16935.99	-0.01	2356 ₃ —19292 ₃		
5957.24	4		16781.65	+0.02	29401 ₂ —46183 ₂	5900.53	3	16942.94	-0.01	24785 ₄ —41739 ₃		
5954.71	4		16788.78	+0.01	22199 ₃ —38987 ₄	5896.63	50Z	16954.14	-0.01			
5954.20	1 <i>h</i>		16790.22			5892.80	3	16965.16	+0.02	29996 ₃ —46961 ₂		
5953.13	1		16793.23			5891.18	5	16969.82	+0.02	29996 ₃ —46966 ₃		
5952.86	2		16794.00	+0.01	25231 ₃ —42075 ₂	5890.46	200Z	16971.90	0.00	18143 ₁ —35115 ₂		
5951.24	1		16798.57			5887.43	20Z	16980.63	+0.03	18011 ₂ —34991 ₁		
5950.26	1		16801.33			5886.31	30Z	16983.86	+0.01	10532 ₄ —27516 ₃		
5949.80	2		16802.63	-0.06	31943 ₂ —48746 ₃	5885.04	3	16987.53	+0.01	28267 ₂ —45254 ₂		
5949.60	1		16803.20	0.00	31943 ₄ —48746 ₃	5883.650	70Z	10	16991.54	0.00	23644 ₃ —40636 ₂	
5949.390	6		16803.79	-0.03	28583 ₃ —45387 ₄	5882.50	2	16994.86	+0.02	22199 ₃ —39193 ₃		
5946.524	7		16811.89	-0.04	5638 ₂ —22450 ₂	5881.44	1	16997.93				
5945.78	1		16813.99	+0.01	32533 ₃ —49347 ₃	5879.772	8	17002.75	+0.02	28267 ₃ —45270 ₁		
5945.12	2		16815.86	-0.04	28267 ₂ —45083 ₃	5873.712	7	17020.29	0.00	25281 ₃ —42302 ₂		
5944.10	1		16818.75	+0.05	31119 ₂ —47937 ₂	5872.93	3 <i>h</i>	17022.56				
5942.41	3		16823.53	-0.08	34947 ₂ —51771 ₂	5871.84	1	17025.72				
5938.80	1		16833.75	+0.04	33994 ₂ —50828 ₁	5869.106	7	17033.65	+0.01	29246 ₄ —46280 ₃		
5938.142	15Z	2	16835.62	-0.02	22450 ₂ —39286 ₁	5868.97	2	17034.04	+0.02	14541 ₃ —31575 ₄		
5936.02	5	20	16841.64	-0.06	27533 ₁ —44375 ₂	5868.50	1	17035.41	-0.01	30733 ₄ —47768 ₃		
5933.70	150Z		16848.22	-0.03	18143 ₁ —34991 ₁	5868.39	2	17035.73	+0.02	29246 ₄ —46282 ₄		
5927.53	2		16865.76			5868.195	8	17036.29	+0.01	29401 ₂ —46437 ₂		
5927.208	5		16866.68	-0.06	23327 ₂ —40194 ₂	5864.32	1	17047.55	-0.05	31943 ₃ —48991 ₂		
5926.48	40Z	5	16868.75	-0.04	23644 ₃ —40513 ₂	5862.07	2	17054.09	-0.02	33139 ₃ —50193 ₂		
5922.94	10		16878.83	-0.01	29401 ₂ —46280 ₃	5860.42	4Z	17058.90	+0.06	27084 ₁ —37843 ₀		
5918.28	1		16892.12	+0.03	28047 ₁ —44940 ₀	5859.34	3	17062.04	-0.01	31943 ₄ —49005 ₄		
5914.73	1		16902.26			5859.07	4	17062.83				
5913.91	2		16904.60	-0.02	17901 ₅ —34805 ₄	5858.349	30Z	17064.93	0.00	23448 ₃ —40513 ₂		
5911.506	4		16911.48			5856.55	1 <i>h</i>	17070.17				

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
5853.76	3		17078.30	-0.01	14541 ₃ ⁸ —31619 ₂	5791.71	10		17261.27	+0.14	27516 ₄ ⁸ —44777 ₄ ⁸
5853.44	1		17079.24	+0.02	26715 ₃ ⁸ —43794 ₄ ⁸	5784.75	2h		17282.04		
5851.54	1		17084.78			5778.92	1		17299.47		
5849.688	60Z	8	17090.19	-0.03	24085 ₅ ⁸ —41175 ₄ ⁸	5776.00	1		17308.22	+0.05	29996 ₃ ⁸ —47304 ₂ ⁸
5847.768	80Z	8	17095.80	0.00	22450 ₂ ⁸ —39546 ₁ ⁸	5774.89	3		17311.55	+0.05	25084 ₂ ⁸ —42395 ₃ ⁸
5847.12	3		17097.70	+0.06	31610 ₂ ⁸ —48708 ₂ ⁸	5774.016	8		17314.17	-0.04	22880 ₃ ⁸ —40194 ₂ ⁸
5845.866	100Z	10	17101.36	-0.03	140117 ₁ ⁸ —31119 ₂ ⁸	5773.33	1		17316.22	+0.01	30755 ₄ ⁸ —48049 ₃ ⁸
5844.879	8	1	17104.25	0.00	18011 ₂ ⁸ —35115 ₂ ⁸	5771.397	15		17322.02	-0.02	8983 ₂ ⁸ —26305 ₃ ⁸
5838.896	40Z	4	17121.78	0.00	10532 ₄ ⁸ —27654 ₃ ⁸	5765.96	30Z	4	17338.36	0.00	22456 ₂ ⁸ —39788 ₂ ⁸
5837.05	6		17127.19	-0.05	32533 ₃ ⁸ —49660 ₃ ⁸	5765.37	40Z	4	17340.13	-0.02	22450 ₃ ⁸ —39790 ₁ ⁸
5818.58	1		17181.56	+0.03	31054 ₃ ⁸ —48236 ₄ ⁸	5762.41	2		17349.04	-0.07	29996 ₃ ⁸ —47345 ₃ ⁸
5818.194	4		17182.70	+0.02	16766 ₄ ⁸ —33949 ₃ ⁸	5758.96	10Z		17359.43	-0.09	29752 ₂ ⁸ —47112 ₃ ⁸
5817.920	6		17183.51	0.00	26305 ₃ ⁸ —43489 ₃ ⁸	5756.83	10Z		17365.85	-0.09	31342 ₃ ⁸ —48708 ₂ ⁸
5817.475	80Z	6	17184.82	-0.03	14435 ₂ ⁸ —31619 ₂ ⁸	5756.51	3		17366.82	-0.03	20784 ₁ ⁸ —38151 ₁ ⁸
5816.499	3		17187.71	+0.03	23448 ₃ ⁸ —40636 ₂ ⁸	5752.18	3		17379.89	-0.03	30977 ₃ ⁸ —48356 ₄ ⁸
5813.14	1		17197.64			5751.718	4		17381.29	-0.04	29401 ₂ ⁸ —46782 ₁ ⁸
5811.275	15	2	17203.16	+0.01	14740 ₂ ⁸ —31943 ₂ ⁸	5751.510	3		17381.92	-0.04	28267 ₃ ⁸ —45649 ₃ ⁸
5810.58	2		17205.22	+0.01	30733 ₄ ⁸ —47938 ₃ ⁸	5748.72	80Z	9	17390.35	-0.03	24785 ₄ ⁸ —42175 ₄ ⁸
5810.26	2		17206.16			5745.22	2		17400.95	{+0.08	33994 ₂ ⁸ —51395 ₃ ⁸
5809.27	5		17209.10	-0.01	29752 ₂ ⁸ —46961 ₂ ⁸	5745.12	1		17401.25	{-0.07	33994 ₄ ⁸ —51395 ₃ ⁸
5808.428	30	2	17211.59	+0.01	14740 ₂ ⁸ —31952 ₁ ⁸	5744.37	1		17403.52	+0.04	31943 ₂ ⁸ —49347 ₃ ⁸
5806.28	1		17217.96	+0.01	25084 ₂ ⁸ —42302 ₂ ⁸	5744.217	10	1	17403.99	{-0.02	31342 ₃ ⁸ —48746 ₃ ⁸
5804.84	1		17222.23	+0.01	28047 ₁ ⁸ —45270 ₁ ⁸	5743.49	1		17406.19	0.00	31943 ₄ ⁸ —49347 ₃ ⁸
5803.64	2		17225.79	-0.01	27149 ₂ ⁸ —44375 ₂ ⁸	5740.93	1		17413.95	-0.07	27533 ₁ ⁸ —44940 ₀ ⁸
5802.88	40Z	3	17228.05	-0.06	16766 ₄ ⁸ —33994 ₄ ⁸	5739.915	4		17417.03	-0.01	33994 ₄ ⁸ —51408 ₅ ⁸
5801.83	6		17231.16	0.00	19292 ₃ ⁸ —36523 ₃ ⁸					0.00	20908 ₂ ⁸ —38332 ₂ ⁸
5800.567	4		17234.92	-0.11	31943 ₄ ⁸ —49178 ₅ ⁸						
5799.760	50Z	5	17237.31	-0.03	23644 ₃ ⁸ —40882 ₃ ⁸						
5796.329	30Z	2	17247.52	-0.03	19791 ₂ ⁸ —37038 ₂ ⁸						
5794.72	10		17252.31	0.00	31342 ₃ ⁸ —48594 ₂ ⁸						

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave number cm ⁻¹	Wave number cm ⁻¹	Intensity Tube	Intensity Spark	
5736.92	7	17426.12	+0.03	25678 ₃ —43104 ₃	5686.18	1	17581.62	17585.87	15	1	—0.02
5736.32	1	17427.94	-0.01	27654 ₃ —45083 ₃	5683.738	4Z	17589.17	17593.10	-0.01	1	25281 ₃ —42871 ₄
5735.986	9	17428.96	+0.02	23448 ₃ —40882 ₃	5682.47	1	17593.10	17593.50	+0.02	2	29752 ₃ —47345 ₃
5735.61	2	17430.10	-0.05		5682.34	2			-0.04		26943 ₆ —44537 ₆
5734.514	50Z	17433.43	-0.05								
5734.13	10	17434.60	-0.01	2356 ₃ —19791 ₂	5681.110	4	17597.31	17599.37	-0.03		31943 ₄ —49540 ₅
5729.683	20Z	17448.13	-0.03	15673 ₃ —33121 ₂	5680.444	10	17602.14	17609.40	-0.02		28583 ₃ —46183 ₂
5724.80	6	17463.01	+0.02	27074 ₄ —44537 ₅	5679.553	30Z			-0.02		14017 ₁ —31619 ₂
5723.880	8	1	17465.82	{+0.01	15673 ₃ —33139 ₃	5677.210	8	17635.79	-0.01		29996 ₃ —47606 ₄
5721.68	3	17472.54	+0.04	32533 ₃ —49999 ₃	5668.716	20Z	2		-0.01		26202 ₃ —43838 ₄
				28583 ₃ —46056 ₂							
5719.175	600Z	100	17480.19	0.00	5664.824	4	17647.90	17653.64	+0.06		28200 ₂ —45848 ₂
5713.267	100Z	10	17498.27	-0.03	5662.982	20Z	2	17656.46	+0.02		23644 ₃ —41298 ₂
5708.38	10	17513.25		24785 ₄ —42283 ₄	5662.078	40Z	4	17659.92	-0.02		14435 ₂ —32091 ₁
5706.85	2	17517.94			5660.97	1					32533 ₃ —50193 ₂
5706.64	5	17518.59	+0.05		5654.645	80Z	9	17679.67	-0.02		22450 ₂ —40130 ₂
58				14092 ₁ —31610 ₂	5650.811	50Z	6	17691.66	0.00		10503 ₂ —28200 ₂
					5649.229	2		17696.62	+0.02		28583 ₃ —46280 ₃
				17526.85	-0.10			17698.71	+0.04		28583 ₃ —46282 ₄
				17532.53	-0.02	31342 ₃ —48869 ₃					
				17535.58		26305 ₃ —43838 ₄					
				17536.47	0.00	29401 ₂ —46937 ₁					
				17540.66	+0.07	20784 ₁ —38325 ₂					
						5642.65	1	17717.25	0.00		31943 ₄ —49660 ₃
				17547.46	-0.02	21738 ₁ —39286 ₁					27533 ₁ —45254 ₂
				17522.14	0.00	29752 ₂ —47304 ₂					30146 ₂ —47876 ₂
				17556.43	-0.02	29752 ₂ —47309 ₁					27654 ₃ —45387 ₄
				17560.50	-0.01	29401 ₂ —46961 ₂					30146 ₂ —47884 ₃
				17561.42	{+0.07	33994 ₃ —51556 ₃					
					[-0.08	33994 ₃ —51556 ₃					
						5635.81	2h				
						5634.45	3h				
						5633.95	10				
						5633.450	20Z	2			
						5633.02	2				
5691.914	3	17563.91	-0.01								
5691.15	1	17566.27	-0.01								
5690.58	1	17568.03									
5690.41	1	17568.55									
5688.12	15	17575.62	-0.02								

1	2		3		4		5		6		Classification o-c cm ⁻¹
	Tube	Intensity	Wave number cm ⁻¹	Spark	Wave number cm ⁻¹	Classification air (Å)	Tube	Intensity	Wave number cm ⁻¹	Spark	
5632.84	3		17748.11		-0.02	26715 ₃ —44463 ₃	5581.45	9	1	17911.52	+0.01
5631.55	3		17752.17		-0.04	33139 ₃ —50891 ₂	5580.69	1		17913.96	-0.06
5631.13	1		17753.50		+0.05	33137 ₁ —50891 ₂	5580.148	8		17915.70	+0.02
5630.10	1		17756.75				5579.90	1		17916.49	
5628.293	40Z		17762.45		+0.03	23448 ₃ —41211 ₂	5578.35	1		17921.47	
5625.66	1		17770.76				5578.008	15Z		17922.57	+0.02
5624.45	1		17774.58				5575.857	200Z		17929.48	-0.01
5618.57	2		17793.18		+0.01	31610 ₂ —49403 ₂	5575.158	8		17931.73	
5615.84	1		17801.83				5573.529	6		17936.97	
5615.63	2		17802.50				5572.30	4		17940.93	+0.06
5614.004	80Z	10	17807.66		+0.02	21738 ₁ —39546 ₁	5569.61	3		17949.59	+0.02
5613.259	400Z	70	17810.02		+0.03	5638 ₂ —23448 ₃	5568.76	1		17952.33	
5611.61	6		17815.25				5568.44	2		17953.37	+0.04
5609.38	2		17822.33		+0.05	33949 ₃ —51771 ₂	5567.22	1		17957.30	
5609.05	2		17823.38				5566.87	2		17958.43	+0.06
5606.613	20Z	2	17831.13		+0.03	23644 ₃ —41475 ₃	5563.32	2		17969.89	
5606.07	1		17832.86		+0.08	31119 ₂ —48951 ₂	5563.19	3		17970.31	+0.09
5602.03	1		17845.72				5561.77	2		17974.90	
5601.15	3		17848.52		{+0.08 -0.03}	27516 ₃ —45364 ₃ 31943 ₄ —49791 ₃	5561.69	3		17975.15	
5600.762	60Z	6	17849.76		0.00	23448 ₃ —41298 ₂	5552.128	1000Z	100	18006.11	-0.02
5600.192	6		17851.57		+0.01	14092 ₁ —31943 ₂	5550.61	1000Z	100	18011.04	0.00
5599.42	1		17854.04		0.00	28583 ₃ —46437 ₂	5548.127	9	1	18019.10	0.00
5599.08	5		17855.12		+0.03	25634 ₂ —43489 ₃	5545.609	4		18027.28	+0.04
5597.546	8		17860.01		+0.02	14092 ₁ —31952 ₁	5545.26	1		18028.41	+0.05
5595.73	3		17865.81		{+0.09 +0.05}	29246 ₄ —47112 ₃ 30733 ₄ —48598 ₃	5541.920	15Z	2	18039.28	-0.02
5595.60	5		17866.22		-0.01		5539.51	1		18042.18	
5594.98	1		17868.20				5538.559	20		18047.13	+0.02
5589.54	1		17885.59		+0.01		5538.275	150	1.5	18051.15	+0.01
5585.013	2		17900.09		+0.01		5538.023	200	20	18051.97	-0.02
5583.934	10	1	17903.55		+0.01	29401 ₂ —47304 ₂					21738 ₁ —39788 ₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave length air (Å)	Wave number cm ⁻¹	Intensity Tube	Intensity Spark	
5535.47	2			18060.30	5498.70		18181.07	+0.01			31610 ₃ —49791 ₃
5535.31	1			18060.82	5497.301		18185.69	-0.05			2245 ₃ —40636 ₂
5534.638	8Z	1		18063.01	5494.54		18194.83	-0.04			2753 ₃ —45728 ₂
5532.23	5			18070.87	5492.89		18200.30				
5531.334	5			18073.80	5492.56		18201.39	+0.05			30977 ₃ —49178 ₃
5531.19	1			18074.27	5492.287		18202.29	-0.05			2975 ₃ —47955 ₂
5530.268	30Z	2		18077.29	5491.87		18203.68	+0.02			30977 ₃ —49180 ₅
5529.01	20			18081.40	5490.48		18208.28				
5525.631	7	1		18092.46	5488.87		18213.63	+0.02			31054 ₃ —49268 ₄
5525.01	10			18094.49	5488.40		18215.19	-0.01			27149 ₂ —45364 ₃
5524.95	10	1		18094.69	{ -0.05 +0.04		18220.76	+0.01			26918 ₁ —45138 ₂
5523.55	3			18099.27	-0.01		18222.76				
5522.84	1			18101.60			18223.89	-0.03			29996 ₃ —48220 ₄
5522.554	20Z	2		18102.54			18240.34				
5521.75	5			18105.17	+0.01		18241.00	+0.01			31952 ₁ —50193 ₂
5520.01	10Z	1		18110.88			18272.15	+0.02			30733 ₄ —49005 ₄
5518.443	10	1		18116.02	+0.03		18274.25	{ 0.00 -0.10			33121 ₃ —51395 ₃
5517.73	1			18118.36							28586 ₁ —46860 ₂ ?
5517.09	2			18120.46	-0.03		18275.96	0.00			15673 ₃ —33949 ₃
5516.75	1			18121.58	+0.01		18280.94	+0.02			31342 ₃ —49623 ₄
5513.97	1			18130.72			18285.42	-0.07			20908 ₂ —39193 ₃
5513.28	1			18132.99	+0.03		18290.73	-0.06			23448 ₃ —41739 ₃
5512.302	10	1		18136.20	-0.02		18298.84	-0.03			18224 ₄ —36523 ₃
5510.436	40Z	7		18142.34	0.00		18321.53	-0.01			15673 ₃ —33994 ₂
5510.116	60Z	6		18143.40	+0.01		18333.70	-0.02			4567 ₄ —22901 ₅
5506.20	1			18156.30			18336.73	-0.01			39286 ₁ —57622 ₃
5503.294	20	2		18165.89	-0.01						
5502.63	10	1		18168.08	-0.01						
5501.53	4			18171.71	-0.01						
5501.01	1			18173.43							

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification	
	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	
5445.23	1			18359.59	+0.01	29246 ⁱ —47606 ⁴	5405.12	1		18495.83	0.00	19791 ₂ —38289 ₂
5445.06	1			18360.17	+0.07	29963 ⁱ —48356 ⁴	5404.457	50Z		18498.10	-0.07	30146 ₂ —48647 ₃
5442.95	3			18367.29	0.00	25194 ⁱ —43561 ₁	5403.60	2h		18501.04	+0.05	28267 ₂ —46782 ₁
5442.565	5			18368.58	+0.02	24085 ₅ —42453 ₄	5399.40	1		18515.43	+0.05	17901 ₆ —36419 ₆
5441.93	2h			18370.73	+0.09	25678 ₃ —44049 ₃	5398.655	10Z	1	18517.98	0.00	
5439.698	15			18378.27	0.00	28583 ⁱ —46961 ₂	5397.484	3		18522.00	0.00	29246 ₄ —47768 ₅
5438.75	100Z			18381.47	-0.03	0 ₂ —18381 ₃	5396.11	4		18526.72	-0.04	20908 ₂ —39435 ₂
5435.781	30Z			18391.51	-0.02	21738 ⁱ —40130 ₂	5394.896	20Z	3	18530.89	+0.01	23644 ₃ —42175 ₄
5434.970	6			18394.25	+0.01	6572 ₁ —24966 ₆	5393.122	8		18536.98	-0.01	29401 ₂ —47938 ₃
5434.74	6			18395.03			5391.59	3		18542.25	+0.05	22880 ₃ —41422 ₃
5434.20	1			18396.86	+0.02	26715 ₃ —45112 ₃	5389.336	10Z	20	18550.00	0.00	8983 ₂ —27533 ₁
5433.728	7			18398.46	0.00	14740 ₂ —33139 ₃	5385.37	2		18563.66	+0.01	30977 ₂ —49540 ₃
5433.190	6			18400.28	+0.03	25444 ₀ —43844 ₁	5385.26	2		18564.04	+0.01	28527 ₁ —47092 ₁
5432.732	2			18401.83	-0.03	27654 ₃ —46056 ₂	5384.65	3h		18566.15	-0.12	29752 ₂ —48319 _{3?}
5430.708	7			18408.69	0.00	28583 ₃ —46992 ₄	5383.04	40Z	4	18571.70	-0.07	23252 ₄ —41824 ₃
5430.17	1			18410.51	+0.08	29963 ⁱ —48407 ₂	5382.083	2		18575.00	0.00	26202 ₂ —44777 ₄
5428.304	15			18416.84	-0.02	23644 ₃ —42061 ₃	5381.02	2		18578.67		
5426.35	1h			18423.47	-0.03	26715 ₃ —45138 ₂	5376.302	10Z	1	18594.97	-0.02	24966 ₆ —43561 ₁
5423.981	60Z			18431.52	-0.02	22450 ₂ —40882 ₃	5373.863	30Z	50	18603.41	-0.01	2356 ₃ —20960 ₁
5423.37	1			18433.60	-0.06	25084 ₂ —43517 ₂	5371.8	2Z	4	18610.57	+0.01	30977 ₂ —49623 ₄
5421.91	1			18438.56			5371.112	15	2	18612.94	-0.06	23448 ₃ —42061 ₃
5421.21	2			18440.94	-0.02	23327 ₂ —41768 ₂	5370.804	9	1	18614.01	-0.06	30733 ₂ —49347 ₃
5420.84	1			18442.20			5368.52	20Z	2	18621.93	-0.01	6572 ₁ —25194 ₁
5419.305	3			18447.42	-0.01	30733 ₄ —49180 ₅	5366.764	2		18628.02	-0.01	27654 ₃ —46282 ₄
5418.75	1			18449.31	-0.05	31342 ₃ —49791 ₃	5361.466	3		18646.43	+0.01	30977 ₂ —49623 ₄
5415.99	1			18458.71			5361.02	1		18647.98	-0.01	29401 ₂ —48049 ₃
5412.17	4			18471.74	-0.01		5360.33	2		18650.38	+0.06	20784 ₁ —39435 ₂
5411.806	2			18472.98	+0.01	29410 ₂ —47874 ₁	5358.54	4		18656.61	-0.02	31342 ₃ —49999 ₃
5410.27	2			18478.23	+0.02	27516 ₄ —45994 ₃	5358.338	40Z	6	18657.31	-0.03	18381 ₃ —37038 ₂
5405.23	2			18495.46	+0.01	29401 ₂ —47896 ₃	5357.355	10		18660.74		

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification	
	Wave-length air (Å)	Tube	Intensity	Spark	Wave-number cm ⁻¹	cm ⁻¹	Wave-number o-c cm ⁻¹	cm ⁻¹	Wave-number cm ⁻¹	cm ⁻¹		
5354.724	200Z	40	18669.91	-0.03	25462 ^a —44132 ₅	5314.016	2	18812.93	-0.02	29996 ₃ —48809 ₃		
5349.774	4		18687.18	-0.04	16766 ₄ —35453 ₃	5309.681	100Z	18828.28	-0.01	16163 ₂ —34991 ₁		
5347.65	1		18694.60	+0.04	28267 ₂ —46961 ₂	5307.812	60Z	18834.91	-0.03	23448 ₃ —42228 ₄		
5347.00	1		18696.88		25084 ₂ —43786 ₁ ^c	5305.83	4	18841.95	-0.01	29752 ₃ —48594 ₂		
5345.40	1		18702.47	+0.04		5304.44	1	18846.89				
5344.93	1		18704.12	+0.07	24785 ₄ —43489 ₃	5304.178	40Z	18847.82	0.00	22450 ₂ —41298 ₂		
5344.31	1		18706.29	+0.06	29752 ₂ —48459 ₂	5303.35	2	18850.76	+0.02	31342 ₃ —50193 ₂		
5343.99	1		18707.41			5300.18	1	18862.04				
5343.75	1		18708.25	-0.05	33139 ₃ —51847 ₃	5300.09	4	18862.36	-0.05	32533 ₃ —51395 ₃		
5341.956	2		18714.53			5294.870	300Z	18880.95	-0.01	4567 ₄ —23448 ₃		
5341.48	1		18716.20	+0.06	23644 ₃ —42360 ₃	5292.783	30Z	18888.40	-0.03	22880 ₃ —41768 ₂		
5340.027	2		18721.29	-0.01	28583 ₃ —47304 ₂	5290.812	20Z	18895.43	-0.02	18143 ₁ —37038 ₂		
5338.386	8	1	18727.04	+0.02	23448 ₃ —42175 ₄	5290.212	10	18897.58	0.00	21738 ₁ —40636 ₂		
5337.10	2		18731.56			5288.40	1	18904.05	+0.06	27533 ₁ —46437 ₂		
5334.34	6	1	18741.25	+0.01	25634 ₂ —44375 ₂	5286.098	70Z	18912.28	0.00	23448 ₃ —42360 ₃		
5332.40	1		18748.07	-0.03	23327 ₂ —42075 ₂	5284.591	10	18917.68	+0.01	29401 ₂ —48319 ₃		
5331.94	2		18749.68	-0.01	29996 ₃ —48746 ₃	5284.28	1	18918.79				
5330.85	1		18753.52			5284.06	1	18919.58	+0.05	20784 ₁ —39704 ₁		
5328.89	10		18760.42	{-0.04	25084 ₂ —43844 ₁ ^c	5281.07	3	18930.29	+0.04	26918 ₁ —45848 ₂		
5327.89	3		18763.94	{-0.06	22450 ₂ —41211 ₂	5280.03	1	18934.02				
				+0.05	27516 ₄ —46280 ₃	5277.16	10	1	18944.31	-0.03		
5327.31	1		18765.98	+0.02	27516 ₂ —46282 ₄	5276.22	1		18947.69			
5324.78	1		18774.90	+0.07	21738 ₁ —40513 ₂	5275.81	3h		18949.16	+0.02	26305 ₃ —45254 ₂	
5324.59	2		18775.57	+0.02	29246 ₄ —48022 ₄	5275.04	150Z	20	18951.93	-0.01	16163 ₂ —35115 ₂	
5324.035	7		18777.52	0.00	26305 ₃ —45083 ₃	5274.018	8	1	18955.60	+0.01	29752 ₂ —48708 ₂	
5322.365	9		18783.41	+0.01	27654 ₃ —46437 ₂	5272.53	8		18960.95		28790 ₁ —47751 ₀	
5320.22	2		18790.99	0.00	26463 ₁ —45254 ₂	5271.38	2		18965.09		25084 ₂ —44049 ₃	
5317.82	2		18799.47	-0.02	29752 ₂ —48552 ₂	5268.88	2		18974.09	0.00	29246 ₄ —48220 ₄	
5316.888	6		18802.76	-0.03	29246 ₄ —48049 ₃	5268.37	1		18975.92			
5315.928	15Z	1	18806.16	-0.04	26463 ₁ —45270 ₁	5266.72	1		18981.87			
5315.578	7		18807.40	-0.02	30733 ₄ —49540 ₅							

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Intensity		Wave number cm ⁻¹		Wave number cm ⁻¹		Intensity		Wave number cm ⁻¹		
Wave-length air (Å)	Tube	Spark			Classification	Wavelength air (Å)	Tube	Spark		Wave number cm ⁻¹	
5262.60	4		18996.73	+0.02	19292 ₃ —38289 ₂	5222.43	10Z	1	19142.84	-0.01	23252 ₄ —42395 ₃
5258.736	40Z	5	19010.69	+0.01	26463 ₁ —45474 ₁	5220.201	1		19151.02	+0.13	29401 ₂ ¹ —48552 ₂ ²
5255.464	15Z		19022.52	-0.02	28583 ₃ —47606 ₄	5217.26	2		19161.81	+0.06	27516 ₄ ² —46678 ₄
5255.09	2		19023.87	+0.05	27654 ₃ —46678 ₄	5216.40	3		19164.97	+0.02	28790 ₁ ² —47955 ₂
5254.48	20Z	3	19026.08	0.00	23644 ₃ —42670 ₄	5212.325	7	1	19179.96		
5253.615	10	1	19029.22	0.00	14092 ₁ —33122 ₂	5212.045	3		19180.99	+0.03	25194 ₁ ² —44375 ₂
5252.91	2		19031.77	-0.01	27149 ₂ —46181 ₃	5208.84	15	2	19192.79	-0.02	18143 ₁ ² —37336 ₁
5252.452	9	1	19033.43	-0.01	27149 ₂ —46183 ₂	5200.866	20Z	2	19222.21	-0.01	23448 ₃ ² —42670 ₄
5251.309	7		19037.57	-0.02	28267 ₂ —47304 ₂	5199.545	10Z	1	19227.10	-0.03	16766 ₄ ² —35993 ₅
5250.11	2		19041.92	+0.02	28267 ₃ —47309 ₁	5196.46	1		19238.51	-0.06	29752 ₂ ² —48991 ₂
5249.12	1		19045.51	-0.12	14092 ₁ —33137 ₂	5193.63	3		19249.00	-0.04	27533 ₁ ² —46782 ₁
5247.031	40Z	3	19053.09	0.00	24785 ₄ —43838 ₄	5192.99	1		19251.37		
5244.67	50Z	4	19061.67	+0.01	6572 ₁ —25634 ₂	5192.58	1		19252.89		
5243.984	250Z	30	19064.16	-0.01	8983 ₂ —28047 ₁	5192.234	7		19254.17	-0.02	14740 ₂ ² —33994 ₂ ²
5243.460	40	3	19066.07	-0.01	18270 ₀ —37336 ₁	5191.46	2		19257.04	-0.04	28047 ₁ ² —47304 ₂
5241.697	4		19072.48	+0.01	29246 ₄ ² —48319 ₃	5191.168	4		19258.12	-0.02	31943 ₃ ² —51201 ₄
5241.040	3		19074.87	+0.03	23644 ₃ ² —42719 ₂	5190.28	1		19261.42	+0.03	28047 ₁ ² —47309 ₁
5240.90	1		19075.38			5189.38	4h		19264.76	+0.08	26463 ₁ ² —45728 ₂
5240.424	10		19077.11	+0.01	4567 ₄ ² —23644 ₃ ²	5186.825	50Z	10	19274.25	-0.01	22901 ₃ ² —42175 ₄
5240.05	1		19078.48	-0.05	28267 ₂ —47345 ₃	5186.13	3h		19276.83		
5239.15	1		19081.75	+0.02	26305 ₃ ² —45337 ₄	5184.295	20Z	2	19283.66	0.00	8983 ₂ ² —28267 ₂
5232.315	3		19106.68			5182.90	8		19288.85	0.00	22450 ₂ ² —41739 ₃
5230.04	1h		19114.99			5181.87	300Z	60	19292.68	0.00	0 ₂ ² —19292 ₃ ²
5229.594	6		19116.62	+0.02	29752 ₂ ² —48869 ₃	5178.02	2		19307.02	+0.03	29401 ₂ ² —48708 ₂
5227.30	2h		19125.01			5177.860	4		19307.62	-0.01	27654 ₃ ² —46961 ₂
5226.89	1h		19126.51			5177.644	10	1	19308.43	-0.01	16766 ₄ ² —36075 ₄
5226.64	1h		19127.43			5176.614	1		19312.27	-0.02	27654 ₃ ² —46966 ₃
5226.030	1h		19129.66			5173.162	15Z	2	19325.15	-0.01	18011 ₂ ² —37336 ₁
5225.755	4		19130.67	+0.02	27149 ₂ ² —46280 ₃	5172.67	2		19326.99	-0.01	27533 ₁ ² —46860 ₂
5225.23	6		19132.59	+0.01	15673 ₃ ² —34805 ₄	5172.15	2		19328.94		

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Intensity	Classification	Wave number cm ⁻¹	Wavelength air (Å)	Intensity	Tube	Spark	Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification
5171.76	2h				19330.39			5133.66		1			19473.85		
5171.44	3h				19331.59			5133.10		15			19475.98	0.00	27516 ₄ —46992 ₄
5171.02	10h				19333.16			5131.38		1			19482.51	+0.06	20784 ₁ —40267 ₂
5170.173	100Z	20			19336.33	-0.02	19791 ₂ —39127 ₃	5130.28		1			19486.68		19791 ₂ —39286 ₁
5168.23	2				19343.60	+0.02	26305 ₃ —45649 ₃	5128.116		8			19494.91	+0.02	
5167.376	30Z	4			19346.79	+0.01	24785 ₄ —44132 ₅	5126.81		3			19499.87	+0.01	29246 ₄ —48746 ₃
5166.390	20Z	2			19350.49	+0.01	29963 ₃ —49347 ₃	5122.727		4			19515.41	-0.01	22880 ₃ —42395 ₃
5164.15	2				19358.88	-0.01	20908 ₂ —40267 ₂	5117.09		10			19536.91		
5162.32	1				19365.74			5112.130		100Z			19555.87	0.00	5638 ₂ —25194 ₁
5161.570	15	2			19368.56	0.00	17901 ₅ —37269 ₄	5111.148		20			19559.63	-0.03	21738 ₁ —41298 ₂
5160.05	2				19374.26			5109.04		1h			19567.70		
5157.95	200Z	20			19382.15	-0.03	22901 ₅ —42283 ₄	5108.55		1			19569.57	-0.02	22199 ₃ —41768 ₂
5157.21	5				19384.93			5107.319		4			19574.29	-0.01	26715 ₃ —46289 ₄
5153.122	40Z	4			19400.31	0.00	17901 ₅ —37301 ₆	5105.64		1			19580.73	+0.01	29401 ₃ —48982 ₁
5148.899	8				19416.22	+0.01	30977 ₃ —50393 ₄	5102.634		2			19592.26	0.00	26463 ₁ —46056 ₂
5148.62	1h				19417.27			5101.668		40Z			19595.97	0.00	27516 ₄ —47112 ₃
5147.401	7				19421.87	0.00		5100.64		60Z			19599.92	-0.03	8983 ₂ —28583 ₃
5145.72	2				19428.21	-0.01		5098.80		2			19606.99	-0.03	28267 ₂ —47874 ₁
5145.22	2h				19430.10			5097.74		2			19611.07	+0.01	22450 ₂ —42061 ₃
5144.30	2				19433.58	-0.03		5097.40		1			19612.38	-0.01	31943 ₂ —51556 ₃
5142.997	9				19438.50	-0.01	28583 ₃ —48022 ₄	5096.21		1			19616.96	-0.05	28790 ₁ —48407 ₂
5141.81	2h				19442.99			5094.683		5			19622.84	+0.04	29246 ₁ —48869 ₃
5141.19	2				19445.33			5094.117		2			19625.02		
5141.044	5				19445.88	0.00	14092 ₁ —33538 ₂	5093.698		5			19626.63	+0.03	29996 ₃ —49623 ₄
5140.202	4				19449.07	-0.03	25634 ₂ —45083 ₃	5091.28		3			19635.95	+0.02	25634 ₂ —45270 ₁
5139.51	5h				19451.69			5090.996		6			19637.05	0.00	28583 ₃ —48220 ₄
5137.86	1				19457.94	-0.10	27654 ₃ —47112 ₃	5090.876		15Z			19637.51	-0.01	10503 ₂ —30146 ₂
5136.52	2				19463.01			5089.50		1			19642.82	-0.06	25673 ₃ —45321 ₄
5136.20	30Z	2			19464.22	-0.05	10532 ₄ —29996 ₃	5087.46		2			19650.70	+0.04	27654 ₃ —47304 ₂
5135.81	5				19465.70	-0.05	28583 ₃ —48049 ₃	5087.37		2			19651.04	-0.08	29752 ₂ —49403 ₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
5086. 96	10	1	19652. 63	-0. 03	16766 ₄ —36419 ₅	5035. 50	1	30Z	3	19853. 46	14740 ₂ —34596 ₁
5086. 482	4		19654. 48	-0. 03	28047 ₁ —47702 ₂	5034. 92				19855. 75	-0. 05
5085. 07	2		19659. 93	-0. 05	30733 ₄ —50393 ₄	5034. 14	2			19858. 83	-0. 12
5084. 74	1		19661. 21	+0. 04	22450 ₂ —42111 ₁	5033. 32	1			19862. 06	-0. 12
5082. 770	2		19668. 83	-0. 01	28790 ₁ —48459 ₂	5029. 99	1h			19875. 21	
5082. 21	3		19671. 00	-0. 04	28267 ₃ —47938 ₃	5029. 71	2			19876. 32	
5081. 77	10	1	19672. 70	-0. 01	5521 ₀ —25194 ₁	5029. 46	3			19877. 31	+0. 01
5077. 614	6		19688. 80	-0. 03	26305 ₃ —45994 ₃	5025. 91	15Z			19891. 35	-0. 04
5076. 29	2		19693. 94	-0. 04	29752 ₂ —49446 ₁	5023. 09	70Z	5		19902. 51	-0. 09
5073. 131	4		19706. 20	+0. 02	27231 ₀ —46937 ₁	5021. 745	40Z	5		19907. 84	-0. 05
5072. 295	8	1	19709. 45	-0. 01	24085 ₃ —43794 ₄	5021. 13	40Z	5		19910. 28	-0. 06
5069. 810	20Z	1	19719. 11	-0. 04	26463 ₁ —46183 ₂	5018. 20	200Z	20		19921. 91	-0. 07
5067. 65	2h		19727. 51		5014. 28	1				19937. 48	
5064. 67	2		19739. 12		5012. 89	1h				19943. 01	
5064. 15	3h		19741. 15		5012. 185	10	1			19945. 81	-0. 04
5061. 80	3h		19750. 31	-0. 10	26305 ₃ —46056 ₂	5011. 01	1h			19950. 49	
5060. 584	5		19755. 06	+0. 01	19791 ₃ —39546 ₁	5008. 068	3			19962. 21	
5058. 778	4		19762. 11	+0. 01	28790 ₁ —48552 ₂	5007. 94	2			19962. 72	-0. 01
5056. 89	10		19769. 49	+0. 03	22901 ₅ —42670 ₄	5007. 21	1			19965. 63	
5055. 93	2		19773. 24	+0. 01	28583 ₃ —48356 ₁	5005. 18	2			19973. 73	-0. 07
5053. 68	2		19782. 05	+0. 01	28267 ₂ —48049 ₃	5004. 50	1			19976. 44	
5051. 319	50Z	3	19791. 29	0. 00	0 ₂ —19791 ₂	5002. 06	2h			19986. 19	
5047. 440	300Z	30	19806. 50	0. 00	8983 ₂ —28790 ₁	5001. 96	3			19986. 59	-0. 04
5043. 102	2		19823. 54	-0. 02	28583 ₃ —48407 ₁	5000. 81	1			19991. 18	
5042. 30	1		19826. 69		5000. 54	20Z	2			19992. 26	-0. 03
5040. 202	15		19834. 94	-0. 02	4999. 21	7				19997. 58	-0. 03
5039. 15	3		19839. 08	-0. 02	4998. 76	1				19999. 38	-0. 02
5038. 08	3		19843. 30	+0. 04	4998. 03	4hs				20002. 30	-0. 01
5037. 74	9Z		19844. 64	+0. 09	4995. 831	2				20011. 11	-0. 01
5035. 899	6		19851. 89	0. 00	4994. 795	4h				20015. 26	{+0. 10 -0. 04}

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2			3			4			5			6		
	Intensity		Wave number cm ⁻¹	4		5	6	Intensity		Tube	Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	
Wave-length air (Å)	Tube	Spark	Classification	Classification	Classification	Classification	Classification	Classification	Classification	Classification	Classification	Classification	Classification	Classification	Classification
4991.06	1			20030.24				4948.951	100Z	15	20200.66	-0.02	10532 ₄ —30733 ₄		
4988.88	1			20038.99	-0.02			4947.336	15Z	2	20207.26	-0.02	14740 ₂ —34947 ₂		
4988.712	2			20039.66	-0.01			4945.84	3		20213.37	+0.05	27654 ₃ —47867 ₂		
4987.28	1			20045.42	+0.04			4944.82	10	1	20217.54	-0.06	4567 ₄ —24773 ₄		
4986.55	1			20048.35	+0.08			4943.42	15Z	2	20223.27				
4986.37	1			20049.08	-0.02			4942.74	1		20226.05	-0.03	28583 ₃ —48809 ₃		
4985.33	3			20053.26	+0.03			4938.717	3		20242.52	-0.05	27654 ₃ —47896 ₃		
4985.17	2			20053.90				4937.810	5		20246.24	-0.04	29732 ₃ —49999 ₃		
4983.70	3h			20059.82				4936.35	3		20252.23	-0.02	27516 ₄ —47768 ₅		
4983.07	1h			20062.35				4934.595	6		20259.43				
4982.72	2h			20063.76				4932.260	7Z		20269.02	-0.02	22450 ₂ —42719 ₂		
4981.73	2			20067.75				4929.55	1		20280.17	+0.04	25194 ₁ —45474 ₁		
4978.724	4			20079.87	+0.04			4928.194	6		20285.75	-0.01	28583 ₃ —48869 ₃		
4975.26				20093.85	-0.01			4927.60	2h		20288.19				
4967.616	5			20124.76	+0.01			4927.15	2		20290.04				
4966.03	1			20131.19	-0.02			4926.594	10	2	20292.33	-0.03	27074 ₄ —47366 ₅		
4965.83	2			20132.00	+0.05			4926.189	30	2	20294.00	0.00	29246 ₄ —49540 ₅		
4965.28	2			20134.23				4925.214	15	1	20298.02	-0.04	24785 ₄ —45083 ₃		
4964.740	4			20136.42	+0.05			4924.54	1		20300.80	-0.06	27654 ₃ —47955 ₂		
4962.381	6			20145.99	-0.01			4923.92	2		20303.35	0.00	24966 ₆ —45270 ₁		
4960.32	1			20154.37				4920.16	2		20318.87	+0.02	26463 ₁ —46782 ₁		
4960.074	5			20155.36	+0.01			4918.094	4		20327.41	0.00	28267 ₂ —48594 ₂		
4958.24	2			20162.82	0.00			4916.98	8		20332.01	+0.01	22450 ₂ —42778 ₁		
4956.813	5			20168.62	-0.06			4915.32	40Z	6	20338.88	-0.06	19791 ₂ —40130 ₂		
4955.94	1			20172.18	+0.06			4914.888	7		20340.67	-0.01	27533 ₁ —47874 ₁		
4955.65	1			20173.36	+0.04			4912.11	5		20352.17				
4951.095	4			20191.92	-0.01			4911.40	1		20355.11	-0.01	25444 ₀ —45799 ₁		
4950.69	2			20193.57	-0.02			4910.10	30Z	2	20360.50	+0.01	16163 ₂ —36523 ₃		
4950.36	1			20194.91				4908.30	1		20367.97	+0.10	27654 ₃ —48022 ₄		
4950.02	3h			20196.30	+0.01			4907.56	3		20371.04	+0.06	25084 ₂ —45455 ₃		

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6	
Wave-length air (Å)	Intensity		Wave number cm ⁻¹		Classification		Wave length air (Å)		Intensity		Wave number cm ⁻¹	
	Tube	Spark					Tube	Spark				
4907.244	6		20372.35	-0.02	26305 ₃ —46678 ₄	4881.74	3		20478.78			
4907.079	6		20373.03	+0.02	21738 ₁ —42111 ₁	4881.27	1		20480.75			
4906.400	6	2	20375.85		4878.166	20Z	4		20493.78			
4906.17	8	1	20376.81	+0.04	29246 ₄ —49623 ₄	4877.587	20		20496.22	0.00	19292 ₃ —39788 ₂	
4903.06	20Z	2	20389.73	0.00	23448 ₃ —43838 ₄	4875.92	2		20503.22	-0.02	16766 ₄ —37264 ₁	
4901.767	5		20395.11	0.00	27654 ₈ —48049 ₃	4875.76	1		20503.90			
4901.44	4		20396.47	+0.08	29996 ₃ —50393 ₄	4875.63	1		20504.44	+0.01	28047 ₁ —48552 ₂	
4901.356	6		20396.82	+0.01	26463 ₁ —46860 ₂	4872.949	50Z		20515.72	-0.02	20960 ₄ —41475 ₃	
4900.179	8	1	20401.72	0.00	15673 ₃ —36075 ₄	4868.84	1		20533.04	0.00	27516 ₄ —48049 ₃	
4898.73	3		20407.76	+0.03	28583 ₃ —48991 ₂	4866.33	3		20543.63	-0.02	14740 ₂ —35284 ₁	
4898.38	1		20409.21						20545.78	+0.02	10508 ₃ —31054 ₃	
4897.26	2		20413.88	-0.03	29246 ₄ —49660 ₃	4865.82	1		20546.94	+0.04	28047 ₁ —48594 ₂	
4896.34	40Z	4	20417.72	+0.01	8983 ₂ —29401 ₂	4865.546	2		20548.91	+0.03	25634 ₂ —46183 ₂	
4895.48	1		20421.30			4865.08	2		20552.75	-0.03	27149 ₂ —47702 ₂	
4895.301	6Z		20422.05	{+0.06 {+0.01}	25634 ₂ —46056 ₂ 27516 ₄ —47938 ₃	4864.17	2		20556.50	-0.02	14435 ₂ —34991 ₁	
4895.086	5		20422.95	+0.04	26943 ₆ —47366 ₃	4861.51	10		20564.00	-0.02	15673 ₃ —36237 ₃	
4894.82	1		20424.06	+0.06	28527 ₁ —48951 ₂	4860.91	2		20566.53	-0.03	25281 ₃ —45848 ₂	
4893.62	2		20429.07	+0.01	31342 ₃ —51771 ₂	4859.24	200Z	30	20573.60	-0.03	14541 ₃ —35115 ₂	
4892.993	5		20431.68	+0.01	30977 ₃ —51408 ₅	4858.42	70Z	7	20577.07	-0.03	6572 ₁ —27149 ₂	
4890.754	6		20441.04	0.00	28267 ₃ —48708 ₂	4857.17	1		20582.37			
4889.932	20Z	2	20444.47	+0.02	10532 ₄ —30977 ₃	4853.993	3		20595.84	0.00	27533 ₁ —48129 ₁	
4889.609	7	1	20445.82			4853.58	1		20597.59	-0.09	29401 ₂ —49999 ₃	
4888.05	3		20452.34	-0.01	24085 ₅ —44537 ₅	4852.53	5		20602.05	0.00	28267 ₂ —48869 ₃	
4887.73	1		20453.68			4851.69	1		20605.62			
4886.84	1		20457.41	-0.01	28527 ₁ —48985 ₆	4850.60	40Z	4	20610.25	-0.07	10508 ₂ —31119 ₂	
4886.47	4		20458.96	+0.08	23327 ₂ —43786 ₁	4849.19	1		20616.24			
4884.65	10		20466.58	0.00	25634 ₂ —46100 ₁	4846.91	1		20625.94			
4884.258	10		20468.22	0.00	30733 ₄ —51201 ₄	4846.02	1		20629.73	+0.01	26715 ₃ —47345 ₂	
4883.66	2		20470.73			4844.19	10		20637.52	-0.06	22880 ₃ —43517 ₂	
4882.48	2		20475.68	+0.06		4842.984	3		20642.66	-0.02	27231 ₀ —47874 ₁	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
4842.185	15	1	20646.07	-0.02	25634 ₂ ¹ —46280 ₃	4808.70	10		20789.83	-0.02	26202 ₃ ¹ —46992 ₁
4841.51	3H		20648.94	-0.03	26305 ₃ ¹ —46961 ₂	4805.723	3		20802.71	-0.01	27516 ₄ ¹ —48319 ₃
4839.82	7		20656.15	-0.03	4805.55	1			20803.46	-0.07	25634 ₂ ¹ —46437 ₂
4839.29	1		20658.42	-0.06	4805.27	4			20804.67	-0.08	27654 ₃ ¹ —48459 ₂
4839.12	2		20659.14	-0.06	4805.076	10			20805.51	-0.04	27149 ₂ ¹ —47955 ₂
4838.79	6		20660.55	+0.02	28047 ₁ ¹ —48708 ₂	4804.05	2		20809.95	0.00	10532 ₄ ¹ —31342 ₃
4838.740	8		20660.76	-0.08	26305 ₃ ¹ —46966 ₃	4800.50	500Z	100	20825.34	+0.02	5638 ₂ ¹ —26463 ₁
4837.80	12	1	20664.78	-0.01	27654 ₃ ¹ —48319 ₃	4798.49	1		20834.07		
4837.238	150Z	20	20667.18	+0.01	5638 ₂ ¹ —26305 ₃	4797.69	3		20837.54	-0.01	19292 ₃ ¹ —40130 ₂
4835.32	7		20675.38	-0.06	30733 ₄ ¹ —51408 ₅	4796.88	2		20841.06	0.00	26463 ₃ ¹ —47304 ₂
4834.20	80Z	10	20680.17	0.00	14435 ₂ ¹ —35115 ₂	4795.98	15Z	2	20844.97	-0.02	19791 ₂ ¹ —40636 ₂
4830.45	3H		20696.22		4794.89	3h			20849.71		
4828.97	5		20702.56	-0.03	27654 ₃ ¹ —48356 ₄	4794.00	4h		20853.58		
4828.58	1h		20704.24	-0.10	27516 ₄ ¹ —48220 ₄	4793.52	3		20855.67	-0.02	14092 ₁ ¹ —34947 ₂
4827.57	1h		20708.57		4793.11	5h			20857.45	+0.10	27074 ₄ ¹ —47931 ₃ ¹
4826.50	1		20713.16	+0.01	14740 ₂ ¹ —35453 ₃	4792.45	1		20860.32	+0.08	20908 ₂ ¹ —41768 ₂
4825.37	2h		20718.01	0.00	27149 ₂ ¹ —47867 ₂	4791.588	9		20864.08	-0.04	24785 ₄ ¹ —45649 ₃
4824.50	2		20721.75		4791.26	7			20865.50		
4824.38	3		20722.26	+0.02	19791 ₂ ¹ —40513 ₂	4788.966	7		20875.50	+0.01	16163 ₂ ¹ —37038 ₂
4823.98	1		20723.98	-0.04	28267 ₂ ¹ —48991 ₂	4787.62	1		20881.37		
4823.80	3		20724.75	-0.03	27149 ₂ ¹ —47874 ₁	4787.52	1		20881.80		
4822.43	1		20730.64	-0.06	23644 ₃ ¹ —44375 ₂	4787.42	3		20882.24		
4818.84	100Z	15	20746.08	-0.06	18381 ₃ ¹ —39127 ₃	4786.16	1		20887.74		
4814.91	2		20763.02		4785.17	2			20892.06		
4814.79	2		20763.54	-0.07	28583 ₃ ¹ —49347 ₃	4784.80	5		20893.67		
4814.62	1		20764.27	+0.05	25084 ₂ ¹ —45848 ₂	4783.83	3		20897.91	+0.07	27231 ₆ ¹ —48129 ₁
4813.500	7		20769.10	-0.01	8983 ₂ ¹ —29752 ₂	4783.392	3		20899.82	+0.02	27149 ₃ ¹ —48049 ₃
4812.19	1h		20774.75		4782.737	200Z	50		20902.69	+0.02	18224 ₄ ¹ —39127 ₃
4811.146	40Z	5	20779.26	-0.03	20960 ₄ ¹ —41739 ₃	4779.66	6		20916.14	-0.01	20908 ₂ ¹ —41824 ₃
4810.11	3		20783.74		4777.216	20Z	2		20926.84	0.00	23448 ₃ ¹ —44375 ₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification	Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
4776.50	1		20929.98			4741.02	10		21086.61	+0.04	17901 ₅ —38987 ₄
4774.994	7		20936.58	+0.04	15673 ₃ —36609 ₃	4739.83	40Z	4	21091.90	-0.02	2356 ₃ —23448 ₃
4774.904	30Z	4	20936.98	+0.01	22901 ₅ —43838 ₄	4738.574	80Z	10	21097.49	+0.01	14017 ₁ —35115 ₂
4773.72	150Z	20	20942.17	+0.01	5521 ₀ —26463 ₁	4738.23	4		21099.03	-0.05	36523 ₃ —57622 ₃
4773.262	15	2	20944.18	+0.01	17901 ₅ —38845 ₃	4738.112	20	3	21099.55	+0.02	15673 ₃ —36772 ₃
4771.262	4		20952.96	+0.02	30977 ₃ —51929 ₅	4737.67	4		21101.52	+0.02	20960 ₄ —42061 ₃
4770.58	1		20955.95			4735.51	40	4	21111.14	{+0.05 -0.09}	10508 ₂ —31619 ₂
4769.83	1		20959.25			4734.29	3		21116.58	-0.02	22450 ₂ —43561 ₁
4769.372	20Z	2	20961.26	+0.06	6572 ₁ —27533 ₁	4731.72	1		21128.05	+0.08	18011 ₂ —39127 ₃
4768.23	2h		20966.28			4730.648	15		21132.84	+0.05	20908 ₂ —42036 ₁
4766.507	10		20973.86	+0.03	14017 ₁ —34991 ₁						23644 ₃ —44777 ₄
4760.907	7		20998.53			4730.396	7		21133.97	{-0.08 -0.03}	25084 ₂ —46218 ₃
4758.789	6		21007.87	+0.01	25281 ₃ —46289 ₄	4729.81			21136.59	+0.02	24966 ₆ —46100 ₁
4757.611	50Z	5	21013.08	0.00	8983 ₂ —29996 ₃	4729.37	1		21138.55	+0.06	28267 ₂ —49403 ₂
4756.94	1h		21016.04	-0.02	18270 ₃ —39286 ₁	4728.42	6		21142.80	+0.01	29752 ₂ —50891 ₂
4756.35	2		21018.65	+0.05	27533 ₁ —48552 ₂	4727.567	5		21146.61	+0.05	18143 ₁ —39286 ₁
4756.08	3d		21019.84	+0.07	26918 ₁ —47937 ₂						29246 ₄ —50393 ₄
4753.97	4		21029.17	+0.02	27018 ₅ —48047 ₄	4725.60	2		21155.42	-0.02	27654 ₃ —48809 ₃
4753.89	3		21029.52	+0.04	27149 ₂ —48179 ₂	4724.54	1		21160.16	-0.08	27149 ₂ —48309 ₁
4753.124	10		21032.91	+0.02	29246 ₄ —50279 ₅	4724.21	2		21161.64	-0.03	27074 ₄ —48236 ₁
4751.492	15		21040.14	-0.01	26305 ₃ —47345 ₃	4722.46	3		21167.29	-0.09	20908 ₂ —42075 ₂
4750.66	7		21043.82	-0.02	21738 ₁ —42782 ₁				21169.48	0.00	27149 ₂ —48319 ₃
4748.89	1		21051.66			4721.71	50Z	5	21172.84	-0.01	16163 ₂ —37336 ₁
4748.35	15	1	21053.80	-0.05	27654 ₃ —48708 ₂	4721.32	2		21174.59	-0.11	27533 ₁ —48708 ₂
4746.78	6		21061.02	-0.05	27533 ₁ —48594 ₂	4720.86	7		21176.66	-0.06	15673 ₃ —36850 ₄
4743.20	1		21076.92	+0.05	28533 ₃ —49660 ₃	4720.25	2		21179.39	-0.04	28267 ₂ —49446 ₁
4742.92	1		21078.16	+0.02	27231 ₆ —48309 ₁	4717.43	30Z	2			14092 ₁ —35284 ₁
4742.530	10		21079.90	0.00	28267 ₃ —49347 ₃						
4741.13	4		21086.12								

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Wavelength air (Å)	Intensity Tube	Intensity Spark	Wavelength cm ⁻¹	Wavelength cm ⁻¹	Wavelength cm ⁻¹	Wavelength cm ⁻¹	Wavelength cm ⁻¹	Wavelength cm ⁻¹	Wavelength cm ⁻¹	
4716.42	2			21196.59	-0.12	30733 ₄ —51929 ₅	4683.94	40	6	21343.57	-0.03
4714.67	1			21204.46		4682.29	4681.86	1	21351.10	+0.07	
4713.82	1			21208.28	+0.11	28583 ₃ —49791 ₃	4681.22	8	21353.06	+0.01	
4713.68	3			21208.91		4681.22	4678.43	1	21355.98	-0.08	
4712.296	10			21215.14	+0.02	27654 ₃ —48869 ₃			21368.71		
4712.205	20	2		21215.55	+0.03	20960 ₄ —42175 ₄	4677.61	2	21372.46		
4711.022	12			21220.88	+0.03	19292 ₃ —40513 ₂	4677.35	2	21373.64		
4709.762	15	2		21226.56	+0.02	25634 ₂ —46860 ₂	4676.71	3	21376.57	-0.01	
4708.85	40Z	5		21230.67	+0.01	22907 ₃ —44132 ₅	4673.318	8	21392.09	+0.03	
4708.053	30Z	4		21234.26		4673.176	20Z	2	21392.74		
4707.59	2			21236.35	0.00	24085 ₅ —45321 ₄	4671.82	2	21398.94	{+0.02	
4706.06	12			21243.25	0.00	25194 ₂ —46437 ₂	4670.94	20Z	2	-0.03	
4704.21	4			21251.61	+0.08	20784 ₁ —42036 ₁	4669.245	50Z	7	{+0.03	
4702.89	2			21257.57	-0.04	27149 ₂ —48407 ₂	4668.23	1	21410.75	-0.02	
4700.30	1			21269.29		4667.292	30	2	21415.40	-0.01	
4699.008	150Z	30		21275.13	-0.01	18011 ₂ —39286 ₁	4663.187	8	21419.70	-0.04	
4698.439	8			21277.71	-0.05	21738 ₁ —43016 ₂	4663.187		21428.56	-0.03	
4695.49	1			21291.07	+0.13	20784 ₁ —42075 ₂	4661.75	3	21445.17	0.00	
4693.56	5			21299.83		4660.86	6		21449.26	-0.09	
4693.422	5			21300.45	0.00	26305 ₃ —47606 ₄	4655.198	300Z	50	21475.35	-0.02
4692.706	4			21303.70	-0.02	25634 ₃ —46937 ₁	4652.258	20	21488.92	-0.04	
4691.453	9			21309.39	-0.05	27149 ₂ —48459 ₂	4651.766	5	21491.19	-0.07	
4690.48	1			21313.81		4651.13	1		21494.13	0.00	
4688.99	4			21320.59		4650.94	5		21495.01	-0.04	
4688.37	40	8		21323.41	-0.03	20960 ₄ —42283 ₄	4650.59	20Z	2	21496.63	-0.04
4687.42	4			21327.73	-0.03	4648.35	10Z		21506.99	-0.08	
4687.155	8			21328.93	0.00	25634 ₂ —46961 ₂			21511.06	+0.03	
4686.388	30	4		21332.43	{-0.09	23448 ₃ —44777 ₄	4647.47	2	21520.65	+0.08	
4685.36	2			21337.11	{+0.01	26715 ₃ —48047 ₄	4645.40	3	21521.43		
4684.33	4			21341.80	+0.02	25634 ₂ —46966 ₃	4645.23	1	21524.49	+0.03	
						27654 ₃ —48991 ₂	4644.57	1	21528.94		
						4643.61					

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity		Wave number cm ⁻¹		Classification	Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
4643.14	<i>3h</i>	4	21531.12	-0.05	<i>18011₂</i> —39546 ₁	4598.801	300Z	30	21738.71	+0.01	<i>0₂</i> —21738 ₁
4642.25	30Z		21535.25		4597.945	4597.945	60Z	6	21742.75	-0.02	23644 ₃ —45387 ₄
4637.39	1		21557.82		3592.70	3592.70	1		21767.59	+0.11	25194 ₁ —46961 ₂
4637.16	1		21558.89	+0.09	4590.537	4590.537	40	4	21777.84	-0.02	18011 ₂ —39788 ₂
4637.06	1		21559.35	-0.04	4589.13	4589.13	3		21784.52	{+0.01 +0.04}	23327 ₂ —45112 ₃
4636.52	15		21561.86	-0.01	<i>26305₃</i> —47867 ₂	4588.81	1		21786.04	-0.06	29996 ₃ —51782 ₂
4635.60	2		21566.14	+0.02	<i>26202₃</i> —47768 ₅	4588.22	5		21788.84	-0.01	25281 ₃ —47070 ₃
4633.25	1		21577.08	+0.02	<i>20908₂</i> —42485 ₁	4585.10	2		21803.67		
4632.042	10		21582.71	-0.01	<i>10508₃</i> —32091 ₁	4585.00	1		21804.14		
4630.608	40Z		21589.41	+0.01	<i>19292₃</i> —40882 ₃	4583.86	2		21809.56	+0.04	28583 ₃ —50393 ₄
4629.002	7		21596.88	+0.01	<i>27149₂</i> —48746 ₃	4583.53	1		21811.13	-0.04	23327 ₂ —45138 ₃
4627.07	<i>3h</i>		21605.90		4567 ₄ —26202 ₃	4582.26	1		21817.18		
4620.862	300Z	30	21634.92	+0.03	16766 ₄ —38407 ₃	4582.08	1		21818.04		
4619.52	20Z	2	21641.21	+0.01	26305 ₃ —47955 ₂	4581.030	10		21823.04	-0.03	21738 ₁ —43561 ₁
4617.78	2		21649.36	-0.05	4579.38	4579.38	8		21830.90	0.00	27516 ₄ —49347 ₃
4614.60	10	1	21664.28	+0.02	<i>27516₄</i> —49180 ₅	4579.05	2		21832.47	-0.06	27149 ₂ —48982 ₁
4614.192	40	4	21666.20	-0.06	<i>25194₁</i> —46860 ₂	4578.18	2		21836.62	-0.05	28527 ₁ —50364 ₂
4613.222	3		21670.75	-0.04	<i>25634₂</i> —47304 ₂	4577.78	2		21838.53		
4612.29	9		21675.13	+0.03	<i>25634₂</i> —47309 ₁	4577.06	1		21841.96		
4611.63	1d		21678.23		4576.60	4576.60	1		21844.16		
4610.288	2		21684.54	-0.01	<i>19791₂</i> —41475 ₃	4575.05	1		21851.56		
4608.093	100Z	10	21694.87	+0.01	6572 ₁ —28267 ₂	4570.510	8		21873.27	-0.07	26305 ₃ —48179 ₂
4607.48	<i>5h</i>		21697.76		4569.910	4569.910	7		21876.14	-0.03	22901 ₅ —44777 ₄
4606.75	6		21701.20		4565.95	300Z	50		21895.11	-0.02	5638 ₂ —27533 ₁
4606.07	<i>4h</i>		21704.40		4562.638	4562.638	15Z	1	21911.00		
4605.309	4		21707.99								
4604.97	<i>3h</i>		21709.59								
4603.524	15		21716.41	-0.01							
4602.75	30	4	21720.06	-0.04							
4598.92	200	20	21738.15	+0.01							

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Wave-length air (Å)	Intensity	Tube	Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave-length air (Å)	Intensity	Wave number cm ⁻¹	Wave number cm ⁻¹
4553.776	80Z	8	21953.64	-0.02	6572 ₁ —28526 ₀	4514.603	5	22144.13	{ -0.03 +0.01	27516 ₂ —49660 ₃	29246 ₃ —51390 ₄
4550.576	8	1	21969.08	-0.01	27654 ₃ —49623 ₄	4514.35	2	22145.37	+0.04	28047 ₂ —50193 ₂	29246 ₃ —51395 ₃
4550.16	40Z	3	21971.09	-0.05	24966 ₀ —46937 ₁	4513.62	2h	22148.95	-0.13	22152.63	
4547.87	30Z	2	21982.15	-0.03	14541 ₃ —36523 ₃	4512.87	1	22153.96	-0.02	28200 ₂ —50354 ₃	
4546.98	15	2	21986.46	-0.05	25084 ₂ —47070 ₃	4512.60	1				
4546.90	10Z	1	21986.84	0.00	18143 ₁ —40130 ₂	4512.51	1	22154.40	+0.01	26202 ₃ —48356 ₄	
4544.775	1		21997.12	+0.01	10532 ₄ —32533 ₃	4511.970	3	22157.05			
4544.02	100Z	10	22000.78	-0.01	19292 ₃ —41298 ₂	4510.96	2	22162.01	-0.01	29246 ₃ —51408 ₅	
4543.01	20	3	22005.67	0.00	5521 ₀ —27533 ₁	4510.52	1	22164.18	+0.07	28200 ₂ —50364 ₂	
4541.71	40	4	22011.97			4506.669	15	22183.12	-0.04	19292 ₃ —41475 ₃	
4540.934	200Z	20	22015.73	+0.01	5638 ₂ —27654 ₃	4504.328	4	22194.64	+0.01	23327 ₂ —45522 ₃	
4537.548	10		22032.16	-0.02	14740 ₂ —36772 ₂	4504.01	1	22196.21	-0.06	20908 ₂ —43104 ₃	
4534.77	1		22045.65			4503.095	15Z	22200.72	-0.04	23448 ₃ —45649 ₃	
4532.74	2		22055.53			4502.01	4	22206.07	-0.03	25678 ₃ —47884 ₃	
4531.87	1d		22059.76			4501.78	2h	22207.21	+0.07	24785 ₃ —46992 ₄	
4531.14	1		22063.31	+0.03	25281 ₃ —47345 ₂	4501.49	3	22208.64	+0.04	14740 ₂ —36949 ₁	
4530.133	12		22068.22	0.00	25634 ₂ —47702 ₂	4499.662	50Z	22217.66	-0.04	6572 ₁ —28790 ₁	
4527.95	2		22078.86	+0.01	16766 ₄ —38845 ₃	4498.94	8	22221.22	-0.03	16766 ₄ —38987 ₄	
4527.67	1		22080.22			4497.52	1	22228.24			
4527.31	1		22081.98			4496.474	10	22233.41	-0.04	25634 ₂ —47867 ₂	
4525.92	15		22088.76	+0.04	14435 ₃ —36523 ₃	4495.83	2	22236.60	0.00	26715 ₃ —48951 ₂	
4523.575	4		22100.21			4495.08	1	22240.31	+0.09	25634 ₂ —47874 ₁	
4523.32	4		22101.46	-0.01	26305 ₃ —48407 ₂	4494.235	3	22244.49	-0.02	26463 ₁ —48708 ₂	
4522.182	8		22107.02	0.00	27516 ₄ —49623 ₄	4493.23	2	22249.46	-0.04	27018 ₅ —49268 ₄	
4521.477	4	1	22110.47	-0.04	25194 ₁ —47304 ₂	4492.16	30Z	22254.76	-0.02	18381 ₃ —40636 ₂	
4520.587	30Z	4	22114.82	0.00	25194 ₁ —47309 ₁	4491.37	1	22258.68	+0.04	22880 ₃ —45136 ₂	
4519.69	2		22119.21	+0.02	18011 ₂ —40130 ₂	4490.90	1	22261.01	+0.07	25084 ₂ —47345 ₂	
4518.305	50Z	5	22125.99	-0.05	16163 ₂ —38289 ₂	4489.03	1	22270.28	-0.03	19791 ₂ —42061 ₃	
4517.32	3		22130.81	-0.07	26463 ₁ —48594 ₂	4488.00	1	22275.39	-0.07	27516 ₄ —49791 ₃	
4517.068	10		22132.05	+0.02	18381 ₃ —40513 ₂	4487.057	2	22280.07	+0.06	23448 ₃ —45728 ₂	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification	
	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Wave length air (Å)	Classification	Wave number cm ⁻¹	Wave number cm ⁻¹	Wave number cm ⁻¹		
4485.253	15	2		22289.03	0.00	26305 ₃ —48594 ₂	4445.92	4	22486.22	+0.07	22901 ₅ —453874	
4483.61	2			22297.20	+0.01	27149 ₂ —49446 ₁	4444.07	1	22495.58			
4482.86	1			22300.93	-0.05	28790 ₁ —51091 ₁	4443.74	15	22497.25	+0.07	14541 ₃ —37038 ₂	
4482.57	2			22302.37	0.00	28526 ₆ —50828 ₁	4443.076	50	22500.61	+0.03	18381 ₃ —40882 ₃	
4482.20	10			22304.21	-0.03	25634 ₂ —47983 ₃	4442.40	3	22504.04	+0.05	26305 ₃ —48809 ₃	
4481.38	1			22308.30	+0.01	25281 ₃ —47590 ₃	4438.038	30	22526.16	+0.02	5521 ₀ —280471	
4480.044	4			22314.95	+0.01	27074 ₄ —49389 ₃	4437.44	6	22529.19	0.00	20960 ₄ —43489 ₃	
4478.94	2			22320.45	+0.03	19791 ₂ —42111 ₁	4435.95	3	22536.76	+0.08	23644 ₃ —46181 ₃	
4478.824	3			22321.03	+0.04	25634 ₂ —47955 ₂	4435.63	3	22538.38	+0.04	23644 ₃ —46183 ₂	
4477.60	5			22327.13	0.00	24785 ₄ —47112 ₃	4434.340	20	22544.94	+0.02	25634 ₂ —48179 ₂	
4474.511	15	2		22342.54	+0.02	24966 ₆ —47309 ₁	4434.123	10	22546.04	+0.03	23448 ₃ —45994 ₃	
4474.063	5			22344.78	-0.02	27654 ₃ —49999 ₃	4432.78	1	22552.87	0.00	26715 ₃ —49268 ₄	
4473.72	1			22346.49		18270 ₆ —40618 ₁	4432.14	3	22556.13	+0.05	25084 ₂ —47640 ₁	
4473.313	15	1		22348.52	+0.01	23644 ₃ —45994 ₃	4432.024	7	22556.72	0.02	25194 ₆ —47751 ₀	
4473.042	20Z	3		22349.88	+0.01	4431.86	4		22557.56	0.00	25678 ₃ —48236 ₁	
4468.96	2			22370.29	+0.15	18143 ₁ —40513 ₂ ?	4431.155	4	22561.15	-0.02	28267 ₂ —50828 ₁	
4468.882	10			22370.68	-0.01	27018 ₅ —49389 ₅	4430.652	15	22563.71	+0.04	26305 ₃ —48869 ₃	
4466.88	1			22380.71		4429.60	4		22569.06			
4465.196	2			22389.15		4429.17	1		22571.26			
4464.29	5			22393.69	+0.01	29246 ₄ —51640 ₄	4428.459	7	22574.88	-0.02	22880 ₃ —45455 ₃	
4462.465	10			22402.85	-0.02	25678 ₃ —48081 ₃	4422.26	60	22606.52	-0.06	10532 ₄ —33139 ₃	
4461.181	200Z	30		22409.30	0.00	5638 ₂ —28047 ₁	4419.76	3	22619.31			
4459.992	15	1		22415.27	+0.03	25634 ₂ —48049 ₃	4418.60	10	22625.25	+0.01	18011 ₂ —40636 ₂	
4457.347	300Z	40		22428.57	+0.01	2356 ₃ —24785 ₄	4418.247	70Z	9	22627.06	0.00	8983 ₂ —31610 ₂
4454.582	7			22442.50	+0.01	26463 ₁ —48906 ₂	4417.91	150Z	20	22628.78	-0.01	5638 ₂ —28267 ₂
4453.728	10			22446.80	+0.09	19292 ₃ —41739 ₃	4416.19	40Z	3	22637.60	-0.02	23644 ₃ —46282 ₄
4453.98	80Z	8		22450.57	+0.03	0 ₂ —22450 ₂	4415.33	1	22642.01	-0.09	22880 ₃ —45522 ₃	
4448.76	2	10H _l		22471.87	+0.09	23327 ₂ —45799 ₁	4412.386	20	3	22657.11	0.00	18224 ₄ —40382 ₃
4448.41	1			22473.63		4407.96	3		22679.86	-0.08	25194 ₁ —47787 ₁	
4448.086	15Z			22475.27	+0.03	4407.84	2		22680.48	-0.11	14092 ₁ —36772 ₂	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Wavelength air (Å)	Intensity Tube	Intensity Spark	Classification		Wave number cm⁻¹ o-c	Wave number cm⁻¹ cm⁻¹	Classification		
									Wavelength air (Å)	Classification	1	2	3	4	5
4406.98	3		22684.90	-0.02	25634 ₂ —48319 ₃	4358.70	5		22936.17	-0.02	20908 ₂ —43844 ₁				
4404.14	20	3	22699.53	-0.05	26305 ₃ —49005 ₄	4357.00	60Z	7	22945.12	+0.04	5638 ₂ —28583 ₃				
4403.62	2		22702.21			4356.306	300Z	40	22948.78	+0.02	4567 ₄ —27516 ₄				
4397.69	5		22732.83	+0.01	23448 ₃ —46181 ₃	4354.16	10		22960.09	+0.01	8983 ₂ —31943 ₂				
4397.382	4		22734.42	{ -0.06	15673 ₃ —38407 ₃	4354.05	10	1	22960.67	+0.06	25634 ₂ —48594 ₂				
				{ -0.06	23448 ₃ —46183 ₂	4353.36	30Z	5	22964.31	+0.02	16163 ₃ —391127 ₃				
4396.528	4		22738.83	-0.05	27654 ₃ —50393 ₄	4352.567	60Z	7	22968.49	-0.02	8983 ₂ —31952 ₂				
4392.311	15	1	22760.66	-0.05	25194 ₁ —47955 ₂	4351.172	30	2	22975.86	+0.05	26202 ₃ —49178 ₃ ?				
4391.27	20	2	22766.06	-0.02	25281 ₃ —48047 ₄	4349.736	50	3	22983.44	+0.03	24785 ₄ —47768 ₅				
4390.720	20	2	22768.91	-0.01	19292 ₃ —42061 ₃	4348.332	15		22990.86	0.00	19292 ₃ —42283 ₄				
4389.926	15	1	22773.03	-0.02	25634 ₂ —48407 ₂	4347.59	2		22994.79						
						4347.113	5		22997.31	-0.01	25084 ₂ —48081 ₁ ₃				
4386.668	3		22789.94	+0.03	23644 ₃ —46437 ₂	4342.63	3		23021.05	+0.02	14017 ₁ —37038 ₂				
4386.075	4		22793.02	-0.01	25084 ₂ —47884 ₃	4340.30	30	2	23033.41	0.00	23644 ₃ —46678 ₄				
4384.629	7		22800.54	+0.05	26202 ₃ —49005 ₄	4339.65	15	2	23036.86	-0.01	23252 ₄ —46289 ₁				
4384.180	9		22802.88	+0.06	22450 ₂ —45254 ₂	4333.86	30	2	23067.63	0.00	18143 ₁ —41211 ₂				
4383.88	2		22804.44	+0.06		4333.75	7		23068.22	+0.02	19292 ₃ —42360 ₃				
						4333.75	7		23086.69	0.00	4567 ₄ —27654 ₃				
4382.429	5		22811.99	-0.05	28533 ₃ —51395 ₃	4330.282	150Z	20	23094.38	+0.04	1838 ₃ —41475 ₃				
4380.966	7		22819.60	+0.01	22450 ₂ —45270 ₁	4328.84	7		23098.17	-0.02	26305 ₃ —49403 ₂				
4380.70	7		22820.99	0.00	24785 ₄ —47606 ₄	4328.13	10								
4379.175	50	3	22828.94	+0.03	6572 ₁ —29401 ₂	4325.46	2		23112.43	+0.12	25634 ₂ —48746 ₃				
4379.064	40Z	3	22829.52	0.00	18381 ₃ —41211 ₂	4323.58	2		23122.48	+0.07	22199 ₃ —45332 ₄				
						4323.50	2		23122.91	+0.08	16163 ₂ —39286 ₁				
4376.58	15	1	22842.47	+0.07	23327 ₂ —46170 ₂	4321.608	7		23133.03	{ 0.00	23327 ₂ —46469 ₁				
4374.44	2		22853.65	-0.09	25084 ₂ —47937 ₂	4318.138	100Z	10	23151.62	-0.01	26305 ₃ —49438 ₂				
4370.02	2		22876.76	-0.05	27516 ₄ —50393 ₄	4317.51	20	2	23154.99	+0.02	18143 ₁ —41298 ₂				
4368.83	5		22882.99	+0.05	19292 ₃ —42175 ₄	4315.83	1		23164.00	-0.02	27516 ₄ —50680 ₃				
4365.377	60Z	6	22901.09	+0.01	14435 ₂ —37336 ₁	4314.35	10		23171.95	+0.03	20960 ₄ —44132 ₅				
						4310.27	1		23193.88	-0.05	22450 ₂ —45649 ₃				
4362.85	3		22914.36	+0.06	22450 ₂ —45364 ₃	4309.362	20	2	23198.77	-0.05					
4362.12	20	2	22918.19	+0.05	25634 ₂ —48552 ₂										
4360.32	10	2	22927.65												
4360.19	7		22928.34	+0.05	19791 ₂ —42719 ₂										
4359.90	1		22929.86												

Appendix B. Observed and Classified Lines of Hf I—Continued

1		2		3		4		5		6	
Wavelength-air (Å)	Intensity	Wavelength cm ⁻¹	cm ⁻¹	Wavelength cm ⁻¹	cm ⁻¹	Wavelength cm ⁻¹	cm ⁻¹	Wavelength cm ⁻¹	cm ⁻¹	Wavelength cm ⁻¹	cm ⁻¹
Tube	Spark	Tube	Spark	Tube	Spark	Tube	Spark	Tube	Spark	Tube	Spark
4306.171	15	1		23215.96	-0.04	23644 ₃ —46860 ₂	4235.08	23605.66	+0.01	22450 ₃ —46056 ₂	
4304.46	1			23225.18	+0.01	19791 ₂ —43016 ₂	4231.187	23627.38	+0.04	16163 ₂ —39790 ₁	
4303.661	40			23229.50	-0.05	23448 ₃ —46678 ₄	4228.074	23644.77	+0.03	0 ₂ —23644 ₃	
4302.596	4			23235.25	0.00	25634 ₂ —48869 ₃	4226.52	23653.47	-0.01	23327 ₂ —46981 ₂	
4300.03	2			23249.11			4223.54	23670.15	-0.01	25281 ₃ —48951 ₂	
4299.698	7			23250.91	+0.04	18224 ₄ —41475 ₃	4221.765	23680.11	+0.01	18381 ₃ —42061 ₃	
4296.45	50Z	5		23268.48	+0.01	5521 ₀ —28790 ₁	4220.45	23687.48			
4294.78	300Z	30		23277.53	+0.01	2356 ₃ —25634 ₂	4219.40	23693.38	+0.03	26305 ₃ —49999 ₃	
4294.02	20	2		23281.65	-0.07	24085 ₅ —47366 ₅	4218.57	23698.04	+0.04	19791 ₂ —43489 ₃	
4292.980	10			23287.29	-0.03	18011 ₂ —41298 ₂	4218.01	23701.19	0.00	23644 ₃ —47345 ₃	
4287.98	4			23314.44	-0.09	15673 ₃ —38987 ₄	4212.72	23730.95	+0.07	22450 ₂ —46181 ₃	
4287.26	40	4		23318.36	-0.03	14017 ₁ —37336 ₁	4210.59	23742.95	-0.01	23327 ₂ —47070 ₃	
4283.65	2			23338.01	+0.04	22880 ₃ —46218 ₃	4209.743	23747.73	0.00	14541 ₃ —38289 ₂	
4283.34	3h			23339.70			4207.07	23762.82	-0.02	5638 ₂ —29401 ₂	
4281.89	4			23347.60	-0.04		4201.55	23794.04	-0.08	18381 ₃ —42175 ₄	
4280.59	4			23354.69	-0.09	26305 ₃ —49660 ₃	4197.43	23817.39	-0.04	20960 ₄ —44777 ₄	
4280.021	10			23357.80	{-0.09}	18381 ₃ —41739 ₃	4195.26	23829.71	-0.04	22450 ₃ —46280 ₃	
4276.305	10			23378.10	{-0.06}	25194 ₁ —48552 ₂	4193.19	23841.47	-0.12	18270 ₃ —42111 ₁	
4275.78	2			23380.97	-0.04	19292 ₃ —42670 ₄	4190.95	23854.22	-0.05	14435 ₂ —38289 ₂	
4275.42	2			23382.93	-0.06	22901 ₁ —46282 ₄	4187.45	23874.15			
4270.42	2			23410.31		16163 ₂ —39546 ₁	4186.54	23879.34	+0.01	27516 ₄ —51395 ₃	
4269.256	40	4		23416.69	-0.04		4184.80	23889.27			
4268.49	4			23420.90	+0.01	10532 ₄ —33949 ₃	4184.29	23892.18	-0.09	27516 ₄ —51408 ₅	
4263.45	150Z	15		23448.58	-0.02	26202 ₃ —49623 ₄	4183.69	23895.61	-0.10	22880 ₃ —46775 ₃	
4260.98	80Z	8		23462.18	+0.02	0 ₂ —23448 ₃	4183.40	23897.27	-0.06	23448 ₃ —47345 ₃	
4256.643	6					10532 ₄ —33949 ₃	4182.59	23901.89	+0.01	27654 ₃ —51556 ₃	
4251.51	6					26305 ₃ —49791 ₃	4180.61	23913.21			
4248.005	4					18224 ₄ —41739 ₃	4178.13	23927.41	-0.05	21738 ₁ —45666 ₂	
4246.20	2					24785 ₄ —48319 ₃	4177.81	23929.24			
4245.168	40Z	4				23448 ₃ —46992 ₄	4174.348	23949.09	-0.01	2356 ₃ —26305 ₃	
						23486.08	0.00	23949.56			
						23514.44	+0.02				
						23533.84	-0.04				
						23543.84	+0.06				
						23549.56	-0.02				

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Intensity	Tube	Intensity	Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity	Wavelength air (Å)	
4172.190	8				23961.47	-0.02	23644 ₃ —47606 ₄	4138.905	10	24154.17	+0.02
4171.248	7				23966.88	0.00	16163 ₂ —40130 ₂	4138.304	2	24157.68	{+0.05
4170.997	20	2			23968.33	+0.01	18143 ₁ —42111 ₁	4136.13		24170.37	{+0.02
4169.02	15				23979.69			4134.15		24181.95	
4168.08	2				23985.10			4132.70	15	24190.43	0.00
4167.87	7				23986.31	-0.12	25281 ₃ —49268 _{4?}	4131.64	1	24196.64	+0.03
4167.24	1				23989.94	+0.03	21738 ₁ —45728 ₂	4130.42	1	24203.79	0.00
4166.86	1				23992.12			4129.22		24210.82	
4166.26					23995.58			4129.11	1	24211.46	
4165.35	4				24000.82	-0.01	16766 ₄ —40767 ₃	4127.628	10	24220.16	+0.04
4164.50					24005.72			4123.22	1	24246.05	-0.04
4163.90	3				24009.18			4120.96	1	24259.35	
4162.706	100	8			24016.06	+0.01	4567 ₄ —28583 ₃	4120.44	2	24262.41	+0.01
4160.97	2				24026.08			4119.518	10	24267.84	
4160.49	1				24028.86			4118.882	40	24271.59	+0.01
4158.60	10				24039.78	-0.03	27516 ₄ —51556 ₃	4118.583	100Z	24273.35	0.00
4158.20	3				24042.09			4116.385	10	24286.31	
4157.64	1				24045.33			4115.88	50Z	24289.29	-0.03
4155.347	20	2			24058.60	+0.03	18224 ₄ —42283 ₄	4115.132	6	24293.70	0.00
4152.17	1				24077.00	-0.01	26202 ₅ —50279 ₅	4112.301	3	24310.43	-0.02
4150.93	4				24084.20	-0.01	24785 ₄ —48869 ₃	4111.946	6	24312.53	0.00
4149.76	1				24090.99	-0.03	22901 ₅ —46992 ₄	4111.108	60	24317.48	-0.01
4147.84	1				24102.14			4110.412	2	24321.60	
4145.759	150Z	15			24114.24	0.00	5638 ₂ —29752 ₂	4109.52	1	24326.88	
4144.77	3				24119.99	+0.04	25084 ₂ —49204 ₁	4109.44	1	24327.35	
4142.824	3				24131.32						
4142.64	1				24132.39						
4141.720	40	4			24137.75	+0.01	8983 ₂ —33121 ₂	4107.76	1	24337.30	0.00
4140.89	1				24142.59	+0.06	26715 ₃ —50857 ₃	4107.09	4	24341.27	
4139.44	3				24151.05	+0.02	24085 ₅ —48236 ₄	4106.553	200Z	24344.45	-0.04
								4105.81	15	24348.86	1

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
4105.63	8		24349.93	+0.09	<i>18011½</i> —42360 ₃	4082.172	5		24489.85	+0.01	23448 ₃ —47938 ₃
4105.58	8		24350.22	+0.04	<i>16163½</i> —40513 ₂	4079.380	2		24506.61	+0.02	23448 ₃ —47955 ₂
4105.10	2		24353.07			4078.880	7		24509.61		
4104.90	1		24354.26			4078.413	90	5	24512.42	0.00	<i>18270½</i> —42782 ₁
4104.234	150Z	8	24358.21	0.00	<i>5638₂</i> —29996 ₃	4077.80	40	2	24516.11	+0.03	22450 ₂ —46966 ₃
4103.578	4		24362.10	+0.02	<i>21738₂</i> —46100 ₁	4076.962	4		24521.14	+0.01	15673 ₃ —40194 ₂
4103.103	8		24364.92	-0.01	<i>25634½</i> —49999 ₃	4076.36	1		24524.77		
4102.22	2		24370.17			4074.92	1		24533.43		
4101.464	2		24374.66	+0.02	<i>26305½</i> —50690 ₃	4074.760	2		24534.40	+0.02	<i>23644₃</i> —48179 ₂
4100.993	7		24377.46	0.00	<i>23644½</i> —48022 ₄	4074.34	1		24536.92		
4100.38	1		24381.10			4072.885	7	1	24545.69	+0.04	19292 ₃ —43838 ₄
4100.13	1		24382.59			4072.641	3		24547.16		
4099.69	4		24385.21			4071.438	4		24554.41	+0.01	8983 ₂ —33538 ₂
4099.35	2		24387.23			4071.006	9		24557.02	+0.02	23327 ₂ —47894 ₃
4099.17	3		24388.30			4070.669	3		24559.05	+0.01	25634½—50193 ₂
4097.975	30	2	24395.41	-0.01	<i>24785½</i> —49130 ₅	4070.297	3		24561.30		
4097.43	1		24398.66			4070.168	2		24562.07	+0.01	24785 ₄ —49347 ₃
4097.25	3		24399.73			4068.256	70	3	24573.62	+0.02	23448 ₃ —48022 ₄
4096.41	1		24404.73			4067.830	100Z	10	24576.19	0.00	<i>18143₁</i> —42719 ₂
4095.49	30	2	24410.21	+0.01	<i>22450½</i> —46860 ₂	4066.21	200Z	30	24585.98	0.00	14541 ₃ —39127 ₃
4094.93	9		24413.55	+0.01	<i>27516½</i> —51929 ₅	4063.754	5		24594.03	+0.03	15673 ₃ —40267 ₃
4094.66	2		24415.16			4062.84	400Z		24600.84	0.00	23448 ₃ —48049 ₃
4094.00	10		24419.10	+0.05	<i>23448₃</i> —47867 ₂	4060.085	4		24606.38	-0.03	<i>10508₂</i> —35115 ₂
4089.06	5		24448.60			4058.77	3		24623.07	-0.03	27018 ₅ —51641 ₆
4088.18	9		24453.86						24631.05		
4087.942	50Z	5	24455.28	0.00	<i>16163½</i> —40618 ₁	4058.626	1		24631.92	+0.02	23252 ₄ —47884 ₃
4087.00	2		24460.92			4058.124	2		24634.97	+0.01	18381 ₃ —43016 ₂
4083.36	300Z	30	24482.72	-0.04	<i>10508₂</i> —34991 ₁	4057.439	80Z	6	24639.13	-0.02	<i>18143₁</i> —42782 ₁
4082.578	3		24487.41	+0.03	<i>22450½</i> —46937 ₁	4055.70	1		24648.31		
4082.477	4		24488.02						24649.69		

Appendix B. Observed and Classified Lines of Hf₁—Continued

1	2			3			4			5			6		
	Intensity		Tube	Spark	Wave number cm ⁻¹			Wave number cm ⁻¹			Wave number cm ⁻¹			Wave number cm ⁻¹	
Wavelength air (Å)	Tube	Spark			Classification	Wavelength air (Å)	Classification	Wavelength air (Å)	Classification	Wavelength air (Å)	Classification	Wavelength air (Å)	Classification	Wavelength air (Å)	Classification
4054.686	20	2	24655.86	+0.02	16766 ₄ —41422 ₃ ^o	4032.266	300Z	15	24792.95	-0.01	2356 ₃ —27149 ₂ ^o	23252 ₄ —48047 ₄ ^o	25281 ₃ —50084 ₂ ^o		
4053.246	40	4	24664.62	-0.14	27074 ₄ —51739 ₃ [?]	4031.924	20	2	24795.05	-0.04					
4050.883	100Z	5	24679.00	{ -0.04	23252 ₄ —47931 ₃ ^o	4030.68	1		24802.70	-0.06					
4049.702	30	2	24686.20	{ -0.01	(4567 ₄ —29246 ₄ ^o)	4030.03	1		24805.70						
4048.664	40	2	24692.53	+0.01	26202 ₃ —50888 ₆	4027.72	1		24820.93						
					14435 ₂ —39127 ₃										
4047.790	15		24697.86	{ +0.07	27149 ₃ —51847 ₃ ^o	4026.470	2		24828.63	-0.04	23252 ₄ —48047 ₃ ^o				
				{ -0.04	26943 ₃ —51641 ₆ ^o	4026.29	2		24829.74						
4047.600	20	1	24699.02	-0.01	21738 ₁ ^o —46437 ₂ ^o	4026.22	1		24830.18						
4046.64		1	24704.88	+0.01	22901 ₅ ^o —47606 ₄ ^o	4024.918	20		24838.21	+0.03	24785 ₄ —49623 ₄ ^o				
4046.041		3	24708.54	0.00	18011 ₂ ^o —42719 ₂ ^o	4023.976	1		24844.02						
4045.444	5		24712.18	0.00	23644 ₃ —48356 ₄ ^o	4022.830	40	2	24851.10	+0.04	14435 ₂ —39286 ₁ ^o				
					4022.151	3h			24855.29						
4045.198	6		24713.69		4021.593	7			24858.74	-0.02	22450 ₂ —47309 ₁ ^o				
4044.370	80Z	8	24718.75	+0.02	4019.68	1			24870.57	+0.05	23448 ₃ —48319 ₃ ^o				
4043.571	2		24723.63		4019.274	1			24873.08	+0.01	18143 ₁ ^o —43016 ₂ ^o				
4041.768	40	2	24734.66		4018.912	9			24875.33	+0.01	24785 ₄ —49660 ₃ ^o				
4041.63	1		24735.50		4017.685	3			24882.92						
					4016.99	1			24887.23						
4040.35	1		24743.34		4015.672	40	2		24895.40	+0.01	22450 ₂ —47345 ₃ ^o				
4039.56	1		24748.18		4013.58	1			24908.37	+0.05	23448 ₃ —48356 ₄ ^o				
4038.646	20	2	24753.78	+0.01	24785 ₄ —49540 ₅ ^o										
4038.379	30	2	24755.42		4013.259	7			24910.36						
4037.64	1		24759.95		4012.24	1			24916.69						
					4011.503	100Z	4		24921.27	0.00	10532 ₄ —35453 ₃ ^o				
4037.224	5		24762.50	-0.01	23644 ₃ —484407 ₂ ^o	4009.862	20		24931.47	+0.01	23327 ₂ ^o —48259 ₁ ^o				
4035.888	3		24770.70		4008.95	1			24937.14						
4035.76	1		24771.48	-0.02	18011 ₂ ^o —42782 ₁ ^o										
4035.65	2		24772.16	+0.02	23448 ₃ —48220 ₄ ^o										
4034.48	4		24779.34		4007.59	1			24945.60						
					4006.90	1			24949.90	+0.06	27018 ₅ ^o —51968 ₄ ^o				
					4006.480	2			24952.51						
					4005.490	3			24958.68	+0.03	23448 ₃ ^o —48407 ₂ ^o				
					4004.679	15	1		24963.73	0.00	14740 ₂ ^o —39704 ₁ ^o				

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave- length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
4004.385	40	2	24965.57	+0.03	8983 ₂ —33949 ₃	3977.383	40	2	25135.05	+0.04	16163 ₃ —41298 ₂
4003.715	10	1	24969.74	+0.02	17901 ₅ —42871 ₄	3975.624	2	25146.17	-0.04	23448 ₃ —48594 ₂	
4003.432	3		24971.51		3973.477	600Z	20	25159.76	+0.04	2356 ₃ —27516 ₄	
4001.53	40	2	24983.38	+0.02	23252 ₄ —48236 ₉	3972.642	3	25165.05	+0.02	23644 ₃ —48809 ₃	
3999.79	1		24994.25		3972.228	20	1	25167.67	+0.01	22880 ₃ —48047 ₄	
3998.15	2		25004.50	+0.03	22880 ₃ —47884 ₃	3969.79	2	25183.12	+0.01	24035 ₃ —49268 ₄	
3998.001	15		25005.43	+0.01	18011 ₂ —43016 ₂	3968.985	10	25188.23	-0.01	26202 ₃ —51390 ₄	
3997.807	20		25006.64	+0.02	24785 ₄ —49791 ₃	3968.008	40	25194.43	-0.05	0 ₂ —25194 ₁	
3997.09	30		25011.13	+0.01	8983 ₂ —33994 ₂	3967.254	30	2	25199.22	0.00	21738 ₁ —46937 ₁
3996.53	1		25014.63	+0.01	20784 ₁ —45799 ₁	3966.938	3	25201.23	-0.01	22880 ₃ —48081 ₃	
3993.35	3		25034.55	+0.04	20960 ₄ —45994 ₃	3966.162	10	25206.16	+0.02	26202 ₃ —51408 ₅	
3992.75	40	2	25038.31	+0.05	6572 ₁ —31610 ₆	3964.04	3	25219.65			
3991.82	2		25044.15	+0.07	21738 ₁ —46782 ₁	3963.944	1	25220.26			
3991.77	1		25044.46	+0.03	26463 ₁ —51508 ₂	3963.472	4	25223.27	+0.01	21738 ₁ —46961 ₂	
3991.25	4		25047.72	+0.05	16163 ₂ —41211 ₂	3962.764	3	25227.77			
3990.524	2		25052.28			3962.04	1	25232.38			
3990.00	1		25055.57			3961.68	1	25234.68			
3989.61	3		25058.02	+0.04	16766 ₄ —41824 ₃	3960.54	1	25241.94			
3989.48	2		25058.84			3960.06	1	25245.00			
3989.37	1		25059.53			3959.702	20	1	25247.28	+0.04	14541 ₃ —39788 ₂
3989.28	1		25060.09			3958.982	15	25251.87	-0.01	22450 ₃ —47702 ₂	
3988.70	2		25063.74	+0.04	23644 ₃ —48708 ₂	3957.73	9	25259.86	+0.02	23448 ₃ —48708 ₂	
3988.128	4		25067.33		25281 ₃ —50354 ₃	3957.440	10	25261.71	{+0.03	20908 ₂ —46170 ₂	
3987.270	20		25072.73	+0.03	25281 ₃ —50364 ₂	3957.026	40	2	25264.36	+0.04	23644 ₃ —48906 ₂
3985.67	6		25082.79	{-0.04 +0.03	19292 ₃ —44375 ₂	3956.39	1	25268.42	+0.05	18224 ₄ —43489 ₃	
3985.57	3		25083.42			3956.080	5	25270.40	+0.04	14017 ₁ —39286 ₁	
3985.32	1		25084.99	0.00	26305 ₃ —51390 ₄	3955.80	3	25272.18		25084 ₂ —50354 ₃	
3983.87	3		25094.12	+0.01	15673 ₃ —40767 ₃	3951.822	100	25297.62	-0.03	2356 ₃ —27654 ₃	
3981.698	80	3	25107.81	+0.02	18381 ₂ —43489 ₃	3951.18	8	25301.73	-0.07	25281 ₃ —50583 ₃	
3981.148	10	1	25111.28	+0.06	14435 ₂ —39546 ₁	3950.78	50	25304.30	0.00	24085 ₅ —49389 ₅	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Classification	Intensity		Wave-number cm ⁻¹	Wave-length air (Å)	Tube	Spark	Intensity	Wave-number cm ⁻¹	5	6	
							1	2									
Wavelength air (Å)	Intensity						Wavelength air (Å)										
Tube	Spark						Tube										
3949.80	7						25310.57		3919.740	9			25504.67	+0.02	22450 ₂ ^s —47955 ₂		
3949.497	20	2					25312.52	+0.03	3919.417	3			25506.78	+0.05	27074 ₄ ^s —52581 ₄		
3948.423	2						25319.40	+0.02	3917.25	1			25520.89				
3948.299	4						25320.20	+0.01	3916.368	30			25526.63	-0.02	14740 ₂ ^s —40267 ₂		
3947.977	9						25322.26	0.00	3916.074	20			25528.55	+0.02	14017 ₁ ^s —39546 ₁		
3945.87	2						25335.78		3915.53	1			25532.10				
3944.59	3						25344.00		3914.17	3			25540.97				
3944.16	1						25346.77	+0.09	3914.060	1			25541.68	+0.03	26305 ₃ ^s —51847 ₃		
3943.60	3						25350.37		3913.93	2			25542.53	+0.04	10532 ₄ ^s —36075 ₄ ^s		
3943.06	40	3					25353.84	+0.06	3913.89	1			25542.79	-0.03	23443 ₃ ^s —48991 ₂		
3942.73	20	1					25355.96	+0.03	3912.67	2			25550.76	+0.03	18011 ₂ ^s —43561 ₁		
3941.92	15	1					25361.17	0.00	3912.436	7			25552.29	-0.02	20908 ₂ ^s —46460 ₁		
3940.346	20	1					25371.30	+0.02	3912.21	1			25553.76				
3939.042	100Z	5					25379.70	-0.01	3911.748	15			25556.78	+0.02	23448 ₃ ^s —49005 ₄		
3938.48	10	1					25383.32		3910.876	4			25562.48	0.00	27018 ₅ ^s —52581 ₄		
3938.20	1						25385.12	-0.12	3910.29	10			25566.31	+0.02	21738 ₁ ^s —47304 ₂		
3937.28	1						25391.06	+0.03	3909.67	2			25570.36				
3935.31	3						25403.77		3909.185	100			25573.54	-0.01	19791 ₃ ^s —45364 ₂ ^s		
3935.11	1						25405.06		3908.800	30			25576.05	{-0.04	25281 ₃ ^s —50857 ₃		
3931.761	20	2					25426.70	+0.02	3906.888	80Z			25588.57	{+0.01	16163 ₂ ^s —41739 ₃		
3931.38	700Z	70					25429.16	-0.02	3906.107	1			25593.69	0.00	14541 ₃ ^s —40130 ₂		
3928.722	10						25446.36	0.00	3905.79	3			25595.76				
3927.585	100Z	15					25453.73	-0.05	3905.520	20			25597.53	0.00	25281 ₃ ^s —50879 ₂		
3927.108	10						25456.82	-0.01	3903.824	6			25608.65				
3926.434	100Z	8					25461.19	+0.01	3903.20	10			25612.75	+0.02	8983 ₂ ^s —34596 ₁		
3923.714	20	1					25478.84	0.00	3902.937	8			25614.47				
3922.784	8						25484.88	+0.03	3901.44	20			25624.30	+0.03	23327 ₂ ^s —48951 ₂ ^s		
3922.312	4						25487.95	+0.05	3900Z	80			25634.18	-0.02	0 ₂ —25634 ₂ ^s		
3922.020	2						25489.85		3899.937				25672.73				
3920.137	3						25502.09	+0.05	3894.08	7			25675.94	+0.07	20784 ₁ ^s —46460 ₁ ^s		

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification		
	Wavelength air (Å)	Intensity Tube	Intensity Spark	Wavelength cm ⁻¹	Wavelength cm ⁻¹	Classification	Wavelength air (Å)	Intensity Tube	Intensity Spark	Wavelength cm ⁻¹	Wave number cm ⁻¹		
3893.26	10	1		25678.14	25679.08	+0.04	22450 ₂ ⁱ —48129 ₁	3860.910	200Z	7	25886.75	+0.04	10532 ₄ ⁱ —36419 ₅
3893.118	60	10	4	25683.34	25686.25	+0.02	19791 ₂ ⁱ —45474 ₁	3858.31	800Z	20	25893.29	-0.01	8933 ₂ ⁱ —34877 ₃
3892.472	30	1		25687.11		+0.01	16766 ₄ ⁱ —42453 ₄	3854.95		1	25910.74	+0.02	2356 ₃ ⁱ —28267 ₂
3892.03	20							3854.638		5	25933.32		
3891.90	30		3								25935.42		
3891.470	10			25689.95	25695.15	+0.04	14435 ₂ ⁱ —40130 ₂	3852.978		40	25937.33	+0.01	19791 ₂ ⁱ —45728 ₂
3890.683	15			25703.87	25704.76	-0.02	5638 ₂ ⁱ —31342 ₃	3852.716		2	25946.59	-0.01	25462 ₆ ⁱ —51408 ₅
3889.362	200Z	30		25727.41		-0.03	10532 ₄ ⁱ —36237 ₃	3852.52		20	25948.36	0.00	16163 ₃ ⁱ —42111 ₁
3889.228	150Z	20				0.00	26202 ₃ ⁱ —51929 ₅	3851.676		1	25949.68		
3885.804	30	2								1	25955.36	-0.01	23448 ₃ ⁱ —49403 ₂
3885.624	2			25728.60		+0.02	22450 ₂ ⁱ —48179 ₂	3850.364		40	25964.21	0.00	8933 ₂ ⁱ —34947 ₂
3885.420	10			25729.95	25730.42		3849.19	1000Z		70	25972.13	-0.06	5638 ₂ ⁱ —31610 ₂
3885.35	1			25749.12		0.00	15673 ₃ ⁱ —41422 ₃	3846.521		7	25990.15	-0.06	23448 ₃ ⁱ —49438 ₂
3882.527	100Z	10		25771.10		+0.01	14017 ₁ ⁱ —39788 ₂	3845.962		8	25993.92	-0.02	18381 ₃ ⁱ —44375 ₂
3879.216	60	5						3844.11		1	26006.45	-0.07	20900 ₄ ⁱ —46966 ₃
3878.947	20	1		25772.89		+0.01	14017 ₁ ⁱ —39790 ₁	3843.402		2	26011.24		
3876.280	30	1		25790.62		0.00	19292 ₃ ⁱ —45083 ₃	3843.214		5	26012.51	-0.01	21738 ₁ ⁱ —47751 ₀
3875.77	1			25794.01		-0.06	23644 ₃ ⁱ —49438 ₂	3842.782		9	26015.43	-0.01	23252 ₄ ⁱ —49268 ₄
3874.99	1			25799.21			23644 ₃ ⁱ —49438 ₂	3841.107		8	26026.78	+0.02	14740 ₂ ⁱ —40767 ₃
3874.08	2			25805.27				3839.55		4	26037.33		
3873.74	1												
3871.605	2			25807.53	25821.76		14017 ₁ ⁱ —39843 ₀	3834.484		4	26053.31		
3870.962	50	3		25826.05		0.00	19791 ₂ ⁱ —45649 ₃	3834.423		7	26071.73	-0.01	22880 ₃ ⁱ —4895J ₂
3867.95	1			25846.16		+0.06	22450 ₂ ⁱ —48309 ₁	3834.23		4	26072.15	-0.01	19292 ₃ ⁱ —45364 ₃
3866.16	1			25858.13			23644 ₃ ⁱ —49438 ₂	3833.667		3	26073.46		
3865.979	10			25859.34		0.00	22450 ₂ ⁱ —48309 ₁	3833.502		40	26077.29	-0.02	10532 ₄ ⁱ —36609 ₃
3865.684	10			25861.31			23644 ₃ ⁱ —49438 ₂	3831.94		1	26078.41	0.00	14435 ₂ ⁱ —40513 ₂
3864.10	1			25871.91				3831.120		40	26089.04		
3863.655	2			25874.89		+0.02	19791 ₂ ⁱ —45666 ₂	3830.658		9	26094.62	0.00	1454I ₃ ⁱ —40636 ₂
3863.436	20	2		25876.36		-0.04	23327 ₂ ⁱ —49204 ₁	3830.018	200Z	50	26102.13	-0.06	14092 ₁ ⁱ —40194 ₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Wave-length air (Å)	Tube	Intensity	Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave length air (Å)	Wave number cm ⁻¹	Wave number cm ⁻¹	
3829.636	100Z	20	26104.40	0.00	16766 ₄ —4287I ₄	3800.452	26305.19	—0.02	5638 ₂ —31943 ₂	—0.09	
3828.506	30	1	26112.44	+0.02	14017 ₁ —40130 ₂	3800.38	26305.69	—0.09	0 ₂ —26305 ₃	+0.01	
3826.46	3		26126.40			3799.83	26309.50	+0.01	1979I ₂ —46100 ₁		
3824.961	50	4	26136.64	+0.01	23252 ₄ —49389 ₅	3799.230	26313.65	+0.01	5638 ₂ —31952 ₁		
3824.58	6		26139.24			3798.68	26317.46	—0.03	10532 ₄ —36850 ₄		
3823.838	5				26144.32	+0.05	22450 ₂ —48594 ₂	3797.18	26327.86		
3822.819	6				26151.29	+0.03	15673 ₃ —41824 ₃	3796.66	26331.46		
3822.64	4				26152.51			3795.704	26338.10	0.00	16766 ₄ —43104 ₃
3820.728	100Z	100			26165.60	+0.01	4567 ₄ —30733 ₄	3795.366	26340.44	+0.02	1454I ₃ —40882 ₃
3819.90	3				26171.27			3794.964	26343.23	—0.03	23448 ₃ —49791 ₃
3819.348	50	7			26175.05	—0.01	14092 ₁ —40267 ₂	3794.66	26345.34		
3818.834	2				26178.57			3792.56	26359.93		
3818.112	15				26183.52			3791.94	26364.24		
3816.59	1				26193.97			3791.907	26364.47	+0.07	1801I ₂ —44375 ₂
3816.069	60	6			26197.54	+0.01	16163 ₂ —42360 ₃	3791.592	26366.66		
3815.542	30	2			26201.16	0.00	14435 ₂ —40636 ₂	3791.398	26368.01		
3814.992	4				26204.94			3791.14	26369.80		
3813.972	5				26211.95	—0.01	23448 ₃ —49660 ₃	3790.87	26371.68		
3813.848	9				26212.80			3790.718	26372.74		
3813.69	1				26213.88			3789.27	26382.82		
3813.34	1				26216.29			3788.837	26385.83	0.00	20960 ₄ —47345 ₃
3813.08	2				26218.08			3788.520	26388.04	+0.03	22880 ₃ —49268 ₄
3811.781	400Z	40			26227.01	0.00	2356 ₃ —28583 ₃	3788.110	26389.10		
3810.61	7				26235.07			3787.980	26390.89	+0.01	21738 ₁ —48129 ₁
3809.882	3				26240.08			3787.375	26391.80	+0.01	1979I ₂ —46183 ₂
3805.44	1				26270.71			3785.46	26396.02	—0.01	1838I ₃ —44777 ₄
3804.533	100	10			26276.98	0.00	2290I ₃ —49178 _{5?}	3788.520	26409.37	+0.01	4567 ₄ —30977 ₅
3804.198	50	4			26279.29	—0.01	2290I ₃ —49180 ₃	3782.437	26430.47	—0.01	5521 ₀ —31952 ₁
3802.652	15				26289.97	—0.01	25678 ₃ —51968 ₄	3781.672	26435.82	—0.11	19292 ₃ —45728 ₂
3801.92	1				26295.03			3781.550	26436.67	0.00	20938 ₂ —47345 ₃

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification cm ⁻¹
	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Wave number cm ⁻¹	
3781.46	5			26437.30				3753.225	100Z	20	26636.18
3781.016	2			26440.41	-0.01	21738 ₁ —48179 ₂		3752.784	20	2	26639.31
3780.620	3			26443.18				3751.824	15	1	26646.13
3779.87	5			26448.42	-0.01	22199 ₃ —48647 ₃		3751.778	10		26646.46
3777.658	2000Z		200	26463.91	-0.02	0 ₂ —26463 ₁		3750.551	1		26655.18
3777.10	5			26467.82	-0.03	25462 ₆ —51929 ₅		3749.829	8		26660.30
3776.78	5			26470.06	-0.02	8983 ₂ —35453 ₃		3748.71	1		26668.26
3773.122	50			26495.72	0.00	14017 ₁ —40513 ₂		3748.672	3		26668.53
3771.98	7			26503.75	+0.03	31119 ₂ —57622 ₂		3748.554	5		26669.37
3770.32	1			26515.41				3746.810	400Z	60	26681.79
3770.10	1			26516.96				3744.002	30	2	26701.80
3768.254	200Z			26529.95	-0.01	10508 ₂ —37038 ₂		3741.396	6		26720.39
3765.558	100Z			26548.95	+0.01	6572 ₁ —33121 ₂		3741.12	2		26722.37
3765.046	100Z			26552.56	0.00	18224 ₄ —44777 ₄		3739.68	2		26732.66
3764.528	90Z			26556.21	-0.02	16163 ₂ —42719 ₂		3739.030	150Z	10	26737.30
3763.943	4			26560.34	+0.11	20784 ₁ —47345 _{2?}		3736.303	20	1	26756.82
3763.524	1			26563.29				3735.364	5		26763.54
3763.232	20			26565.35	0.00	6572 ₁ —33137 ₁		3733.786	1000Z	100	26774.85
3761.79	2			26575.54				3732.99	2		26780.56
3760.75	1			26582.89				3730.760	20	1	26796.57
3757.554	20	1		26605.50	-0.03	24785 ₄ —51390 ₄		3729.093	150Z	15	26808.55
3756.98	1			26609.56				3728.378	3		26813.69
3756.850	3			26610.48	-0.01	24785 ₄ —51395 ₃		3728.179	2		26815.12
3756.645	2			26611.93	+0.07	14092 ₁ —40704 ₁		3727.092	3		26822.94
3756.17	1			26615.30				3726.485	150Z	15	26827.31
3755.99	1			26616.57				3725.68	1		26833.11
3755.71	2			26618.56	+0.09	14017 ₁ —40636 ₂		3724.444	2		26842.01
3755.620	4			26619.20	+0.01	16163 ₂ —42782 ₁		3723.38	5		26849.68
3755.024	5			26623.42	-0.01	24785 ₄ —51408 ₅		3723.00	2		26852.42
3754.26	1			26628.84	+0.05	15673 ₃ —42302 ₂		3722.904	4		26853.11

Appendix B. Observed and Classified Lines of Hf I—Continued

1		2		3		4		5		6	
Wavelength air (Å)		Intensity		Wave number cm ⁻¹		Wave number cm ⁻¹		Classification		Intensity	
Tube	Spark	Tube	Spark	Classification	Wavelength air (Å)	Tube	Spark	Classification	Wavelength cm ⁻¹	Wave number cm ⁻¹	
3721.500	80	7	26863.24	0.00	14435 ₂ —41298 ₂	3693.60	20	3	27066.15	19791 ₂ —46860 ₂	
3717.802	1000Z	100	26889.96	-0.01	2356 ₃ —29246 ₄	3693.156	10		27069.41	18011 ₂ —45083 ₃	
3717.144	80	7	26894.72	+0.01	5638 ₂ —32533 ₃	3692.770	4		27072.24	-0.02	
3716.054	30	2	26902.61	-0.01	25678 ₃ —52581 ₄	3691.45	2		27081.92	14740 ₂ —41824 ₃	
3712.642	7		26927.34			3691.185	20	2	27083.86	-0.05	
3712.52	1		26928.22			3690.10	3		27091.82	+0.09	
3712.22	4		26930.40			3688.756	9		27101.70	{+0.02 -0.01}	
3711.83	1		26933.23			3687.84	2		27108.43	23252 ₄ —50354 ₃	
3711.692	3		26934.23	+0.05	14541 ₃ —41475 ₃	3687.76	2		27109.02		
3710.353	3		26943.95			3687.42	9		27111.51	-0.02	
3709.044	4		26953.46	+0.03	22450 ₂ —49403 ₂	3685.94	4		27122.40		
3708.85	1		26954.87			3685.352	3		27126.73	-0.01	
3708.500	3		26957.41			3683.57	5		27139.85	-0.02	
3707.92	1		26961.63			3682.247	200		27149.60	-0.04	
3707.374	70Z	7	26965.60	0.00	6572 ₁ —33538 ₂	3677.681	3		27183.31		
3707.02	1		26968.17	-0.01	20908 ₂ —47761 ₁	3677.50	1		27184.65		
3704.938	40	3	26983.33	-0.01	18381 ₃ —45364 ₃	3676.716	3		27190.44		
3704.351	6		26987.60	-0.01	19292 ₃ —46280 ₃	3676.34	9		27193.22	+0.01	
3704.067	15		26989.67	-0.01	19292 ₃ —46282 ₄	3675.742	400Z	150	27197.65	{-0.03 (14541 ₃ —41739 ₃)}	
3703.816	10		26991.50	+0.01	19791 ₂ —46782 ₁	3674.07	2		27210.02	-0.08	
3703.154	2		26996.33	+0.04	22450 ₂ —49446 ₁	3673.06	3		27217.51	0.00	
3702.93	1		26997.96	-0.03	18381 ₃ —45387 ₄	3672.304	300Z	30	27223.11	17901 ₅ —45124 ₆	
3701.83	15		27005.98			3669.49	15	1	27243.98	+0.10	
3699.57	5		27022.48			3668.59	2		27250.67		
3698.83	3		27027.88	{-0.12 -0.12}		3668.19	100Z	10	27253.64	+0.04	
3697.61	4		27036.80						27260.70	+0.06	
3697.08	50	4	27040.68	-0.04	14435 ₂ —41475 ₃	3667.24	5		27267.84	-0.02	
3696.524	400Z	40	27044.74	-0.03	2356 ₃ —29401 ₂	3666.279	20		27280.56	+0.01	
3695.72	2		27050.63			3664.57	80	8	27284.66	0.00	
3694.16	40	4	27062.05	-0.05		3664.020	1		27289.57		
						3663.36	10				

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6	
Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	
	Tube	Spark					Tube	Spark				
3661.711	3	2	27301.86	27304.29	+0.02	14435 ₂ —41739 ₃	3635.254	20	27500.56	+0.04	5638 ₂ —33139 ₃	
3661.385	30	2	27311.94	27325.82	-0.04	16163 ₂ —43489 ₃	3634.144	5	27508.95			
3660.36	1		27325.90			3634.12	4	27509.14			19791 ₂ —47304 ₂	
3658.50	2					3633.513	5	27513.73	+0.03		14541 ₃ —42061 ₃	
3658.49	6					3632.694	40	27519.94	0.00			
3658.22	1		27327.91			3630.872	100	27533.74	0.00		0 ₂ —27533 ₁	
3657.776	15		27331.23	+0.01		3628.96	2	27548.25			19791 ₂ —47345 ₃	
3657.428	2		27333.83			3628.116	10	27554.66	+0.02		24085 ₅ —51641 ₆	
3656.406	2		27341.47			3627.850	70Z	10			(23644 ₃ —51201 ₄)	
3655.652	30	2	27347.11	0.00		3627.230	7	27556.68	{-0.03		14740 ₂ —42302 ₂	
3654.756	5		27353.81	+0.01		3625.93	3	27561.39	-0.05			
3654.57	1		37355.21			3625.42	1					
3653.46	1		27363.52			3622.311	4					
3653.34	1		27364.42			3621.79	1					
3652.76	2		27368.76			3620.510	10					
3651.838	400Z	40	27375.67	0.00	4567 ₄ —31943 ₄	3620.432	6	27613.14	+0.03		18381 ₃ —45994 ₃	
3650.535	100	10	27385.44	-0.03	19292 ₃ —46678 ₄	3620.041	100Z	10	27616.12	0.00		5521 ₀ —33137 ₁
3649.106	700Z	60	27396.17	0.00	2356 ₃ —29752 ₂	3618.732	30	27626.11	-0.01		8983 ₂ —36609 ₃	
3647.54	5		27407.93			3618.684	20	27626.48	0.00		14433 ₂ —42061 ₃	
3646.63	1		27414.77			3617.699	50	27634.00	+0.04		14541 ₃ —42175 ₄	
3645.351	6		27424.39	0.00	18224 ₄ —45649 ₃	3616.892	2000Z	200	27640.16	+0.02		2356 ₃ —29996 ₃
3641.80	1		27451.13			3615.034	300Z	30	27654.37	+0.04		0 ₂ —27654 ₃
3639.97	1		27464.93			3613.268	10	27667.89				
3639.95	1		27465.08			3612.479	30	27673.93	-0.01		19292 ₃ —46966 ₃	
3638.885	1		27473.12			3612.127	10	27676.63	+0.04		14433 ₂ —42111 ₁	
3638.728	15			{+0.02								
3637.594	90Z	7	27482.87	0.00	22880 ₃ —50354 ₃	3611.462	4	27681.72				
3637.06	1		27486.90		20784 ₁ —48259 ₁	3611.42	2	27682.04				
3636.31	1		27492.57		5638 ₂ —33121 ₂	3610.851	8	27686.41				
3635.425	150Z	10	27499.26	-0.02	5638 ₂ —33137 ₁	3609.116	50	27699.71	+0.01			

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Classification	Intensity	Intensity	Intensity	Intensity	Intensity	Intensity	Classification
Wavelength air (Å)	Tube	Spark	Wavelength cm ⁻¹	Wave number cm ⁻¹	Wavelength cm ⁻¹	Wavelength cm ⁻¹	Tube	Tube	Spark	Tube	Tube	Tube	Wavelength cm ⁻¹
													o-c cm ⁻¹
3608.646	8		27703.32	-0.06	22380 ₃ —50533 ₃	3588.258	7		27860.72				
3607.844	3		27709.48	+0.05	18011 ₂ —45728 ₂	3587.84	2		27863.63	+0.01			23644 ₃ —51508 ₂
3606.784	5		27717.62			3587.23	5		27868.71				
3606.231	2		27721.87			3587.142	20	4	27869.39				10532 ₄ —38407 ₃
3605.50	1		27727.49			3586.383	15	1	27875.29	+0.04			
3605.322	2		27728.86			3585.073	6		27885.48	-0.02			22199 ₃ —50084 ₂
3605.26	1		27729.34			3584.215	3		27892.15				
3603.994	15		27739.08	0.00	20908 ₂ —48647 ₃	3583.267	100Z	10	27899.53	0.00			5638 ₂ —33538 ₂
3603.626	40	4	27741.91	+0.03	14541 ₃ —42283 ₄	3582.006	4		27909.35	0.00			20960 ₄ —48859 ₃
3602.914	2		27747.40			3581.564	15		27912.80	0.00			18143 ₁ —46056 ₂
3602.42	1		27751.20			3579.899	150	15	27925.78	+0.02			14435 ₂ —42360 ₃
3602.202	3		27752.88	+0.03	23448 ₃ —51201 ₄	3577.96	1		27940.91				
3601.68	1		27756.90			3577.546	7		27944.14	0.00			14092 ₁ —42036 ₁
3599.867	200Z	60	27770.88	-0.01	16766 ₄ —44537 ₅	3576.43	1		27952.86				
3598.614	7		27780.55	+0.04	10508 ₂ —38289 ₂	3575.44	1		27960.60				
3598.510	6		27781.35			3574.813	20	2	27965.51	-0.02			8983 ₂ —36949 ₁
3597.501	60Z	10	27789.14	+0.03	8983 ₂ —36772 ₂	3574.785	10	1	27965.73	+0.05			45674—32535 ₃
3596.27	3		27798.66			3574.39	1		27968.82	-0.05			30146 ₂ —58115 ₂
3596.11	1		27799.89	-0.03	18381 ₃ —46181 ₃	3573.074	8		27979.12				
3595.888	2		27801.61	+0.03	18381 ₃ —46183 ₂	3572.016	20	2	27987.40	0.00			22901 ₃ —50888 ₆
3595.06	1		27808.01			3570.971	4		27995.59	0.00			23644 ₃ —51640 ₄
3593.608	30	2	27819.25	+0.03	14541 ₃ —42360 ₃	3567.360	600Z	50	28023.93	0.00			6572 ₁ —34596 ₁
3593.55	5		27819.70	+0.01	19292 ₃ —47112 ₃	3566.59	1		28029.98				
3592.67	1		27826.51			3565.46	3		28038.86				
3592.12	1		27830.77	+0.11	18270 ₆ —46100 ₁	3565.216	5		28040.78				
3590.86	1		27840.54			3564.868	10		28043.52	-0.03			20908 ₂ —48951 ₂
3590.349	9		27844.50	0.00	15673 ₃ —43517 ₂	3564.652	40	2	28045.22	{+0.07			18011 ₂ —46056 ₂
3589.684	3		27849.66	-0.01	20960 ₄ —48899 ₃	3564.307	200Z	30	28047.93	-0.04			20960 ₄ —49005 ₄
3589.557	2		27850.64			3563.634	30	3	28053.23	+0.02			19292 ₃ —47345 ₃
3588.849	10	1	27856.14			3563.253	7		28056.23	-0.02			18381 ₃ —46437 ₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Intensity		Wave number cm ⁻¹		Classification		Wave length air (Å)		Intensity		
Wave-length air (Å)	Tube	Spark	Wave number cm ⁻¹	cm ⁻¹	Wave number cm ⁻¹	cm ⁻¹	Tube	Spark	Wave number cm ⁻¹	cm ⁻¹	
35558.470	100	10	28093.94	28104.90	+0.04	14017 ₁ —42111 ₁	3530.870	80	28313.54	-0.01	19292 ₃ —47606 ₄
35557.083	10		28105.59		-0.02	19791 ₂ —47896 ₃	3529.694	3	28322.97	+0.01	23448 ₃ —51771 ₂
35556.995	20		28113.06			3529.358	10		28325.67		
35556.05	5		28121.33		+0.05	3528.217	30		28334.83		
35555.004	30	1				3526.872	80	4	28345.63	+0.01	16766 ₄ —45112 ₃
3554.015	150	20	28129.16	28133.71	0.00	14541 ₃ —42670 ₄	3526.651	20	28347.41	-0.01	14435 ₂ —42782 ₁
3553.44	5		28147.15			3525.547	90	1	28356.29	+0.04	5638 ₂ —33994 ₂
3551.743	20		28155.45		+0.01	3523.025	1000Z	5	28376.58	+0.03	2356 ₃ —30733 ₄
3550.696	30	1	28163.89		-0.01	3522.223	30		28383.05		
3549.632	20					3521.560	100	10	28388.39	-0.01	17901 ₅ —46289 ₄
3549.218	10		28167.17		+0.06	20784 ₁ —48951 ₂	3520.270	10	28398.79	-0.04	23448 ₃ —51847 ₃
3548.816	300	30	28170.36	28177.91	-0.02	18011 ₂ —46181 ₃	3519.62	10	28404.04		
3547.865	30	1	28193.24		-0.01	14541 ₃ —42719 ₂	3517.732	60	28419.28	+0.04	20784 ₁ —49204 ₁
3545.937	50	2	28200.55		+0.02	20784 ₁ —48985 ₆	3516.817	80	28426.67	-0.02	18011 ₂ —46437 ₂
3545.017	20	1				3516.105	4		28432.43		
3543.828	3		28210.01		+0.16	14092 ₁ —42302 _{2?}	3515.06	2	28440.88	+0.08	22450 ₂ —50891 ₂
3543.56	10		28212.15		+0.06	16163 ₂ —44375 ₂	3513.535	40	28453.23	+0.05	18224 ₄ —46678 ₄
3542.503	60		28220.56		0.00	20960 ₄ —49180 ₅	3513.271	300Z	28455.36	+0.06	10532 ₄ —38987 ₄
3541.65	2		28227.36			3511.297	100	5	28471.36	0.00	14541 ₃ —43013? ₅
3541.45	1		28228.95			3510.418	20		28478.49		
3541.33	3		28229.91		+0.03	22450 ₂ —50680 ₃	3509.077	30	28489.37	-0.04	22901 ₃ —51390 ₄
3540.166	10		28239.19			3508.248	30	1	28496.11	+0.02	24085 ₅ —52584 ₄
3536.630	400Z	50	28267.43		+0.03	0 ₂ —28267 ₂	3506.872	10	28507.29	-0.02	22901 ₃ —51408 ₅
3534.498	30	2	28284.48		+0.02	14435 ₂ —42719 ₂	3500.990	10	28553.18		
3534.041	4		28288.13			3500.575	6		28558.56		
3532.978	40	2	28296.65		0.00	18381 ₃ —46678 ₄	3498.988	100Z	28571.52	+0.03	4567 ₄ —33139 ₃
3532.500	5		28300.47			3497.498	1500Z	150	28583.69	0.00	0 ₂ —28583 ₃
3531.83	3		28305.84			3497.168	400	60	28586.39	0.00	0 ₂ —28586 _{2?}
3531.224	200Z	15	28310.70		+0.03	5638 ₂ —33949 ₃	3494.99	20	28604.20	-0.02	19292 ₃ —47896 ₃
3530.947	50	2	28312.92		+0.02	10532 ₄ —38845 ₅	3494.174	60	28610.88	0.00	18381 ₃ —46992 ₄

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
3493.994	7		28612.35			3468.99	5		28818.58	+0.01	18143 ⁱ —46961 ₂
3493.726	7		28614.55			3468.926	4		28819.11		
3493.551	15		28615.98	+0.02	19791 ₃ —48407 ₂	3467.569	150Z	15	28830.39	-0.01	15673 ₃ —44503 ₂
3493.20	1		28618.86	+0.10	10508 ₂ —39127 ₃	3467.410	20	1	28831.71	-0.05	20960 ₄ —49791 ₃
3492.242	10		28626.71			3465.120	30	1	28850.77		
3492.012	6		28628.59			3464.720	50	2	28854.10		
3491.587	60	1	28632.08			3464.12	2		28859.09	+0.07	22880 ₃ —51739 ₃
3490.540	70	2	28640.67	-0.01	22450 ^g —51091 ₁	3462.12	5		28875.77		
3489.918	6		28645.77	+0.01	19292 ₃ —47938 ₃	3461.77	3		28878.69		
3489.628	10		28648.15			3461.33	5		28882.36		
3489.29	2		28650.93			3461.250	6		28883.02		
3488.324	10		28658.86	+0.03	22199 ₃ —50857 ₃	3460.720	20		28887.45	+0.05	18224 ⁱ —47112 ₃
3488.018	30	2	28661.37	0.00	10532 ₄ —39193 ₃	3459.98	2		28893.62		
3487.886	10		28662.46	-0.05	19292 ₃ —47955 ₂	3458.69	8		28904.40		
3484.718	100	6	28688.52	-0.02	16766 ₄ —45455 ₃	3458.18	1		28908.66		
3483.111	50	2	28701.75	-0.02	14017 ₁ —42719 ₂	3456.831	30		28919.94	-0.01	16163 ₂ —45083 ₃
3481.895	70	3	28711.77	-0.01	6572 ₁ —35284 ₁	3456.39	2		28923.63		
3481.410	15		28715.77	-0.01	23252 ₄ —51968 ₄	3455.998	10		28926.92	+0.04	18011 ₂ —46937 ₁
3481.05	7		28718.74			3455.858	10		28928.09	+0.03	19292 ₃ —48220 ₄
3476.573	40		28755.73	-0.01	16766 ₄ —45522 ₃	3453.525	40	3	28947.63	0.00	14541 ₃ —43489 _a
3476.450	20		28756.74	-0.02	19292 ₃ —48049 ₃	3453.136	40	3	28950.89	-0.03	18011 ₂ —46961 ₂
3475.89	7		28761.38			3452.619	10		28955.22	0.00	19791 ₂ —48746 ₃
3475.483	30	2	28764.74	+0.01	14017 ₁ —42782 ₁	3452.576	15		28955.58	0.00	18011 ₂ —46966 ₃
3475.16	60	3	28767.42	+0.01	18224 ⁱ —46992 ₄	3452.304	70Z	10	28957.87	+0.01	5638 ₂ —34596 _i
3473.982	30		28777.17	+0.02	14740 ₂ —43517 ₂	3451.522	20	1	28964.43	0.00	18381 ₃ —47345 ₃
3472.410	800Z	100	28790.20	-0.04	0 ₂ —28790 ₁	3450.54	1		28972.67		
3470.910	10		28802.64			3449.82	6		29878.72	+0.04	24085 ₃ —53063 ₄
3470.800	15		28803.55	+0.03	19791 ₂ —48594 ₂	3448.969	50	3	28895.87	+0.05	2356 ₃ —31342 ₃
3470.300	7		28807.70	0.00	19791 ₂ —48598 ₃	3448.284	100Z	8	28991.62		
3469.91	1		28810.94			3447.446	30	2	28998.67	+0.02	14011 ₂ —43016 ₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification		Wave-length air (Å)	Intensity		Wave number cm ⁻¹	
Wave-length air (Å)	Tube	Spark	Tube	Spark	Tube	Tube	Spark	Tube	Spark	cm ⁻¹	
3445. 068	10		29018. 69		3415. 747	7		29267. 78			
3444. 140	7		29026. 51	+0. 07	3414. 543	2		29278. 10			
3441. 835	150Z	8	29045. 94	+0. 02	3414. 313	7		29280. 07	+0. 05		10508 ₂ —39788 ₂
3440. 860	100	6	29054. 17	+0. 00	3412. 687	8		29294. 02	+0. 07		18011 ₂ —47304 ₂
3439. 669	20	1	29064. 23	-0. 01	3412. 374	100Z	10	29296. 71	+0. 04		14541 ₃ —43838 ₄
3438. 428	300Z	30	29074. 72	+0. 02	3412. 016	20		29299. 78	+0. 07		20784 ₁ —50084 ₂
3437. 15	1		29085. 53		3411. 734	5		29302. 20	+0. 07		19292 ₃ —48594 ₂
3436. 81	9		29088. 41	+0. 06	3411. 253	10		29306. 33	+0. 02		19292 ₃ —48598 ₃
3436. 438	40	2	29091. 56	-0. 01	3410. 892	7		29309. 44	+0. 10		5638 ₂ —34947 ₂
3435. 277	15		29101. 39	+0. 06	3409. 724	10		29319. 48	+0. 04		20960 ₄ —50279 ₅
3434. 969	15	1	29104. 00	+0. 05	14740 ₂ —43844 ₁			29321. 01	{+0. 09		18381 ₃ —47702 ₂
3434. 639	50	4	29106. 80	+0. 02	16163 ₂ —45270 ₁			29328. 46	{-0. 01		22450 ₂ —51177 ₁ ₂
3432. 577	9		29124. 28		3408. 679	8		29328. 46	+0. 04		23252 ₄ —52581 ₄
3432. 28	2		29126. 80	+0. 15	3408. 63	7		29328. 89			18011 ₂ —47345 ₃
3431. 79	3		29130. 96		3407. 928	20		29334. 93	+0. 04		8933 ₂ —38325 ₃
3431. 189	10		29136. 06		3407. 140	50Z	10	29341. 71	-0. 01		
3427. 430	150Z	20	29168. 02	+0. 04	3406. 58	1		29346. 53			
3426. 478	30	1	29176. 12	-0. 03	3405. 89	4		29352. 48	-0. 04		
3423. 656	8		29200. 17	+0. 04	3405. 304	6		29357. 53			
3423. 500	20		29201. 50	+0. 01	3403. 200	10		29375. 68			
3423. 08	7		28205. 08		3402. 512	200Z	20	29381. 62	-0. 02		
3422. 542	15		29209. 67		3401. 73	3		29388. 37			
3420. 775	20		29224. 76		3400. 218	200	20	29401. 44	-0. 01		0 ₂ —29401 ₃
3420. 00	1		29231. 38		3398. 54	3		29415. 96			
3419. 87	2		29232. 49		3397. 602	100Z	20	29424. 08	+0. 02		8983 ₂ —38407 ₃
3419. 80	5		29233. 09		3397. 257	200Z	20	29427. 10	+0. 03		4567 ₄ —33995 ₄
3419. 171	500Z	90	29238. 47	+0. 04	5638 ₂ —34877 ₃			29432. 33			
3417. 34	300Z	30	29254. 14	+0. 02	2356 ₃ —31610 ₂			29434. 58			15673 ₃ —45112 ₃
3416. 82	3		29258. 59		3395. 888	100	4	29438. 93	+0. 03		19292 ₃ —48746 ₃
3416. 52	1		29261. 16		3394. 162	10		29453. 90	+0. 07		4567 ₄ —33995 ₄
					3393. 900	15		29456. 17	-0. 05		20908 ₂ —50364 ₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
3392.815	150 ^Z	40	29465.59	+0.01	17901 ₅ —47366 ₆	3372.201	60Z	5	29645.71	0.00	5638 ₂ —35234 ₁
3392.450	30	1	29468.76		16163 ₂ —45649 ₃	3371.92	7		29648.18	+0.01	15673 ₃ —45324 ₁
3391.43	1		29477.62	+0.01	16163 ₂ —45666 ₂	3371.46	10		29652.22		
3390.465	50	5	29486.02	+0.01	3371.04	20			29655.92		
3388.534	3		29502.82	+0.01	3368.850	4			29675.20	+0.01	20908 ₂ —50533 ₃
3386.907	6		29516.99	{ +0.09 -0.10	14740 ₂ —44257 ₁	3368.50	3		29678.28		
3386.214	150 ^Z	20	29523.03	-0.05	19292 ₃ —48809 ₃	3366.681	100Z	20	29694.31	-0.02	14092 ₁ —43786 ₁
3383.80	3		29544.09	+0.13	16766 ₄ —46289 ₄	3365.452	2		29705.16		
3383.040	2		29550.73		14017 ₁ —43561 ₁	3365.20	1		29707.38		
3382.79	1		29552.91		3364.600	20			29712.68	0.00	19292 ₃ —49005 ₄
3382.334	30	1	29556.90	-0.04	3364.157	10			29716.59		
3381.377	40	3	29565.26	0.00	3363.74	15			29720.27	-0.05	20960 ₄ —50680 ₃
3380.062	15		29576.76	-0.01	3363.44	2			29722.93	+0.09	14740 ₂ —44463 ₃
3379.712	7		29579.83	+0.05	3362.52	1			29731.06	+0.03	18143 ₁ —47874 ₁
3378.932	150	10	29586.65	+0.02	3361.22	6			29742.56		
3378.876	60	6	29587.14	0.00	2356 ₃ —31943 ₂	3360.060	200Z	30	29752.82	-0.03	0 ₂ —29752 ₂
3377.02	5		29603.40		3358.965	100Z	20		29762.52	-0.03	5521 ₀ —35264 ₁
3376.90	2		29604.46		3358.906	50Z	10		29763.05	0.00	14740 ₂ —44503 ₂
3376.517	9		29607.81	-0.002	3358.187	20			29769.42	-0.09	22199 ₃ —51968 ₄
3376.055	15		29611.87		3356.788	80			29781.82	0.00	15673 ₃ —45455 ₃
3375.844	7		29613.72	-0.02	19292 ₃ —48906 ₂	3356.34	4		29785.80		
3375.548	2		29616.31		3355.01	20			29797.61	-0.01	1838I ₃ —48179 ₂
3375.265	15		29618.80		3354.70	7			29800.36		
3374.974	10	1	29621.35	0.00	3353.50	7			29811.02	+0.01	23252 ₄ —53063 ₄
3372.78	10		29640.62	-0.08	3353.028	50	4		29815.22	+0.01	5638 ₂ —35453 ₃
					3350.33	40			29839.23	-0.01	1838I ₃ —48220 ₄
					3349.24	20			29848.94	-0.08	15673 ₃ —45522 ₃
					3348.710	7			29853.66		18011 ₂ —47867 ₂
					3348.38	5			29856.61	0.00	19791 ₂ —49660 ₃
					3346.95	4			29869.36	+0.09	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
3346.05	5		29877.40	3327.46		30044.31	+0.09		21738 ₁ ⁱ —51782 ₂		
3345.334	1		29883.79	3326.92		30049.19			19292 ₃ ⁱ —49347 ₃		
3345.10	6		29885.88	3326.315		30054.65	+0.03		19292 ₃ ⁱ —49347 ₃		
3345.01	1		29886.68	3326.063		30056.93			19292 ₃ ⁱ —49347 ₃		
3344.305	20	1	29892.98	3324.395		30072.01			19292 ₃ ⁱ —49347 ₃		
3342.73	5		29907.07	3323.77		30077.66	+0.08		18381 ₃ ⁱ —48459 ₂		
3341.870	4		29914.76	3323.09		30083.82			18381 ₃ ⁱ —48459 ₂		
3341.29	1		29919.96	3323.03		30084.36			18381 ₃ ⁱ —48459 ₂		
3341.05	6		29922.11	3322.719		30087.18			18381 ₃ ⁱ —48459 ₂		
3340.98	1		29922.73	3322.48		30089.34			18381 ₃ ⁱ —48459 ₂		
3340.459	9		29927.40	3321.946	1	30094.18	+0.03		18224 ₄ ⁱ —48319 ₃		
3340.13	1		29930.35	3321.50		30098.22			18224 ₄ ⁱ —48319 ₃		
3339.34	7		29937.43	3321.274		30100.27			18224 ₄ ⁱ —48319 ₃		
3339.02	6		29940.30	3321.146		30101.43			18224 ₄ ⁱ —48319 ₃		
3338.594	9		29944.12	3320.97		30103.02			18224 ₄ ⁱ —48319 ₃		
3337.995	7		29949.49	3321.50		30109.75	0.00		10508 ₂ ⁱ —40618 ₁		
3337.73	5		29951.87	3321.274		30111.27	-0.02		19292 ₃ ⁱ —49403 ₂		
3336.39	1		29963.90	3319.43		30116.99	+0.05		16163 ₂ ⁱ —46280 ₃		
3336.08	20		29966.68	3319.257		30118.56	+0.02		18011 ₂ ⁱ —48129 ₁		
3335.108	30	1	29975.42	3318.281	2	30127.42	+0.02		10508 ₂ ⁱ —40636 ₂		
3334.388	10		29981.89	3316.167	10	30146.62	0.00		17901 ₅ ⁱ —48047 ₄		
3333.906	20		29986.22	3314.77		30159.33			19292 ₃ ⁱ —49403 ₂		
3332.737	600Z	100	29996.74	3314.11		30165.33	+0.02		14092 ₁ ⁱ —44257 ₁		
3331.857	50	4	30004.66	3313.98		30166.52	+0.03		18143 ₁ ⁱ —48309 ₁		
3331.44	10		30008.42	3312.869		30176.63	-0.01		2356 ₃ ⁱ —32533 ₃		
3330.183	20	1	30019.75	3312.06	1	30184.00			17901 ₅ ⁱ —48047 ₄		
3329.40	10		30026.80	3310.274		30200.29	-0.02		6572 ₁ ⁱ —36772 ₂		
3328.73	2		30032.85	3309.54		30206.98			8983 ₂ ⁱ —39195 ₃		
3328.42	10		30035.65	3309.193		30210.15	-0.03		18381 ₃ ⁱ —48598 ₃		
3327.705	15		30042.10	3308.390	10	30217.48	-0.01				

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
3307.36	1		30226.89			3290.05	1		30385.92		
3306.374	60	2	30235.91	+0.04	14541I ₃ —4477 ₄	3288.722	15		30398.19	-0.02	14740 ₂ —4513B ₂
3306.110	300Z	30	30238.32	+0.06	4567 ₄ —34805 ₄	3288.31	2		30402.00	+0.05	19791 ₂ —50193 ₂
3304.60	3		30252.14			3287.286	70Z	10	30411.47	+0.01	14092 ₁ —44503 ₂
3304.42	1		30253.79			3286.50	1		30418.74		
3303.871	30	2	30258.81			3286.26	1		30420.96		
3303.317	7		30263.89	+0.03	18143 ₁ —48407 ₂	3285.644	30		30426.67		
3302.94	7		30267.34			3285.472	6		30428.26	-0.01	18381I ₃ —48809 ₃
3302.26	2		30273.58			3285.213	8		30430.66	-0.01	20900 ₄ —51390 ₄
3302.164	20	2	30274.46	+0.08	16163 ₂ —46437 ₂	3284.81	3		30434.39		
3301.06	1		30284.58			3282.977	100		30451.38	-0.07	8983 ₂ —39435 ₂
3300.290	10		30291.65			3279.002	10		30488.30		
3299.662	40		30297.41			3278.080	40	1	30496.87	+0.08	15673 ₃ —46170 ₂
3298.934	80	6	30304.10	+0.03	16766 ₄ —47070 ₃	3277.83	4		30499.20	+0.02	19292 ₃ —49791 ₃
3298.495	10		30308.13	+0.05	18011I ₂ —48319 ₃	3276.431	30	1	30512.22		
3298.350	40	2	30309.46	+0.06	4567 ₄ —34877 ₃	3275.44	15		30521.45	-0.09	18224 ₄ —48746 ₃
3297.673	10		30315.68	-0.01	18143 ₁ —48459 ₂	3275.065	8		30524.95	+0.03	18381I ₃ —48906 ₂
3296.445	4		30326.98	+0.04	18381I ₃ —48708 ₂	3272.930	30		30544.86	-0.03	15673 ₃ —46218 ₃
3296.027	20	1	30330.82	+0.08	19292 ₃ —49623 ₄	3272.03	1		30553.26		
3295.585	30	1	30334.89	0.00	17901 ₅ —48236 ₄	3269.65	1		30575.50		
3294.745	15		30342.62			3268.653	7		30584.83	+0.03	18224 ₄ —48809 ₃
3293.998	3		30349.50			3268.32	1		30587.94	-0.01	18011I ₂ —48598 ₃
3293.457	10		30354.49			3268.25	3		30588.60		
3293.116	60Z	4	30357.63	0.00	140117 ₁ —44375 ₂	3267.165	80Z	10	30598.75	+0.02	5638 ₂ —36237 ₃
3292.312	10		30365.05	+0.04	18381I ₃ —48746 ₃	3267.000	70Z	10	30600.30	+0.04	16766 ₄ —47369 ₃
3292.095	4		30367.05			3265.97	1		30609.95	+0.03	18381I ₃ —48991 ₂
3291.600	50	3	30371.61	+0.06	14740 ₂ —45112 ₃	3265.570	15		30613.70		
3291.340	30		30374.01	-0.01	18224 ₄ —48598 ₃	3265.281	80Z	10	30616.41	+0.05	15673 ₃ —46289 ₄
3291.043	150Z	100	30376.75	+0.02	6572 ₁ —36949 ₁	3264.903	7		30619.95		
3290.25	2		30384.08			3264.485	15		30623.87	+0.01	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Wavelength air (Å)	Intensity Tube	Intensity Spark	Wavelength cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity Tube	Intensity Spark	Wavelength cm ⁻¹	Wave number cm ⁻¹
3262.469	100Z	15	30642.80	-0.01	10532 ₄ —41175 ₄	3240.991	80	15	30845.86	+0.01	14541 ₃ —45387 ₄
3261.898	50	10	30648.16	-0.02	14435 ₂ —45083 ₃	3240.77	7		30847.96	-0.07	18143 ₁ —48991 ₂
3261.52	2		30651.71			3240.62	4		40849.39		
3261.39	3		30652.93			3239.393	80Z	8	30861.08		
3260.947	2		30657.10			3239.010	20	2	30864.72	-0.02	22199 ₃ —53063 ₄
3260.63	1		30660.08			3238.274	10		30871.74		
3260.12	1		30664.88			3236.76	100Z	10	30886.18	0.00	4567 ₄ —35453 ₃
3259.97	1		30666.29			3235.80	2		30895.34	-0.04	18011 ₂ —48906 ₂
3258.88	2		30676.54			3235.25	4		30900.59	+0.03	19292 ₃ —50193 ₂
3258.84	1		30676.92			3233.23	1		30919.90		
3258.57	3		30679.46			3232.999	2		30922.11	-0.08	14017 ₁ —44940 ₀
3258.50	2		30680.12	-0.11		3232.593	1		30925.99		
3256.96	4		30694.63			3232.204	20		30929.71	-0.01	14435 ₂ —45364 ₃
3256.66	1		30697.45			3230.058	100Z	10	30950.26		
3254.854	40	5	30714.49	+0.02		3229.493	15	1	30955.68	-0.01	18224 ₄ —49180 ₅
3252.144	9		30740.08			3228.43	1		30965.87	+0.07	18381 ₃ —49347 ₃
3249.529	200Z	20	30764.82	+0.02		3228.320	2		30966.92	-0.04	10503 ₂ —41475 ₃
3249.154	7		30768.37			3227.868	40	3	30971.26	+0.01	5633 ₂ —36609 ₃
3248.49	10	1	30774.66	+0.09		3225.78	1		30991.31		
3247.88	30	3	30780.44	+0.05		3224.77	1		31001.01		
3247.67	400Z	80	20782.43	-0.02		3223.45	1		31013.71		
3246.923	40	2	30789.51	+0.03		3222.538	30	1	31022.48	+0.01	18381 ₃ —49403 ₂
3245.960	15		30798.64	+0.03		3220.032	10		31046.63	+0.01	14092 ₁ —45138 ₂
3245.472	10		30803.27	0.00		3218.770	70Z	5	31058.80	-0.02	14740 ₂ —45799 ₁
3244.66	1		30810.98			3216.94	10		31076.47		
3244.42	4					3216.01	1		31085.45		
3243.735	7					3214.230	20	1	31102.67	+0.04	15673 ₃ —46775 ₃
3243.343	100Z	10	30823.49	-0.02		3213.708	70Z	5	31107.72	{+0.02	14541 ₃ —45649 ₃
3242.130	30	2	30835.02	+0.01		3212.64	4		31118.06	{+0.01	(14740 ₂ —45848 ₃)
3241.734	9		30838.79	+0.01		3211.976	30	4	31124.49	-0.05	16766 ₄ —47884 ₃

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
3210.965	100Z	10	31134.29	+0.05	5638 ₂ —36772 ₂	3190.27	3		31336.25	-0.01	18011 ₂ ^a —49347 ₃
3210.70	10		31136.86	+0.06	16163 ₂ ^b —47309 ₁	3189.63 ^c	100Z	20	31342.52	+0.02	0 ₂ —31342 ₃
3209.757	3		31146.01	+0.06		3187.15	2		31366.92	-0.05	17901 ₅ ^b —49266 ₄
3209.25	5		31150.93			3186.44	3		31373.91		
3209.21	5		31151.32			3186.04	1		31377.85		
3208.12	2		31161.90			3185.03	4		31387.80	+0.06	19292 ₃ ^b —50680 ₃
3207.77	1		31165.30	+0.05	16766 ₄ ^b —47931 ₃	3184.51	1		31392.93	0.00	18011 ₂ ^b —49403 ₂
3206.80	7		31174.73			3184.05 ^c	20	2	31397.40	+0.05	15673 ₃ ^b —47070 ₃
3206.108	150Z	30	31181.46	0.00	2356 ₃ ^b —33533B ₂	3183.27	1		31405.16		
3205.545	10	1	31186.93	-0.02	14541 ₃ ^b —45728 ₂	3183.18	1		31406.04		
3204.39	1		31198.17			3182.74 ^c	10		31410.36	0.00	18381 ₃ ^b —49791 ₃
3203.10	10	1	31210.74	+0.03	8983 ₂ ^b —40194 ₂	3182.57	2		31412.06		
3202.74	30	2	31214.24	0.00	14435 ₂ ^b —45649 ₃	3181.14 ^c	70Z	10	31426.10	+0.01	45674 ^b —35993 ₅
3202.37	10		31217.85			3181.00 ^c	80Z	10	31427.51	+0.01	5521 ₀ ^b —36949 ₁
3201.065	10		31230.58	+0.07	10598 ₂ ^b —41739 ₃	3180.81	20	2	31429.44	0.00	14740 ₂ ^b —46170 ₂
3201.020	20	1	31231.02	-0.02	14435 ₂ ^b —45666 ₂	3180.19	10		31435.57	-0.02	18224 ₄ ^b —49660 ₃
3200.40	8		31237.07	-0.04	14011 ₁ ^b —45254 ₂	3179.62	40	5	31441.20	+0.01	14092 ₁ ^b —45533 ₀
3199.262	20	2	31248.18			3178.43 ^c	40Z	5	31452.92	-0.03	14541 ₃ ^b —45994 ₃
3198.841	10		31252.29	-0.03	14011 ₁ ^b —45270 ₁	3178.05	10		31456.74	-0.06	14011 ₁ ^b —45474 ₁
3198.69	2		31253.77			3175.95 ^c	10		31477.47	-0.07	14740 ₂ ^b —46218 ₃
3198.00	2		31260.51	-0.07	18143 ₁ ^b —49403 ₂	3174.88 ^c	30Z	6	31488.12	-0.04	17901 ₅ ^b —49389 ₅
3197.39	2		31266.47			3172.94 ^c	300Z	70	31507.31	-0.09	45674 ₄ ^b —36075 ₄
3196.916	60Z	10	31271.11	-0.06	6572 ₁ ^b —37843 ₆	3172.24	6		31514.35		
3196.10	4		31279.09	+0.03	18381 ₃ ^b —49666 ₃	3172.08	1		31515.94		
3195.87	10		31281.34	+0.04	16766 ₄ ^b —48047 ₄	3170.83	2		31528.36		
3195.162	5		31288.27			3169.76 ^c	10		31538.98	-0.09	
3194.776	20		31292.05	+0.02	10532 ₄ ^b —41824 ₃	3169.60	4		31540.60		
3193.16	10		31307.89	+0.02	15673 ₃ ^b —46981 ₂	3168.390	100Z	40	31552.64	-0.08	10508 ₂ ^b —42061 ₃
3192.362	7		31315.71	+0.03	18224 ₄ ^b —49540 ₅	3168.26	8		31553.94		
3191.938	10		31319.87			3167.15	1		31564.99		

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Intensity		Wave number cm ⁻¹		Wave number cm ⁻¹		Classification		Wave number cm ⁻¹		
Wave-length air (Å)	Tube	Spark	Tube	Spark	Tube	Spark	Tube	Spark	Tube	Spark	Wave number cm ⁻¹
3166.97	3		31566.79		3147.28		31764.27		-0.05		19791 ₂ —51556 ₃
3165.730	50Z	10	31579.15	-0.03	3147.22	2	31764.87				
3165.27	1		31583.74		3146.22	2	31774.97		-0.12		16163 ₂ —47938 _{3?}
3164.385	100Z	20	31592.57	-0.03	3144.46	7	31792.75				
3163.360	30	3	31602.81	-0.02	3142.57	1	31811.87		+0.13		18381 ₃ —50193 _{2?}
3162.575	300Z	30	31610.65	-0.15	3139.29	4	31845.11		-0.06		14435 ₂ —46280 ₃
3161.536	20Z	3	31621.04	-0.03	3138.651	200	31851.59		-0.03		45667 ₄ —36419 ₃
3161.23	1		31624.10		3138.43	20	31853.84				
3161.09	2		31625.50		3137.520	70Z	30		-0.04		10532 ₄ —42395 ₃
3160.231	10		31634.10	+0.05	3135.770	20	31863.07		-0.05		16766 ₄ —48647 ₁
3159.34	300Z	40	31638.01	-0.17	3135.562	30	31880.86				
3158.82	7		31648.23	-0.12	3133.83	1	31900.59				
3158.71	4		31649.33		3133.30	1	31905.90		-0.03		19292 ₃ —51201 ₄
3158.44	1		31652.04		3133.03	1	31908.74		+0.03		15673 ₃ —47590 ₃
3157.08	3		31665.67	+0.01	3132.236	20	31916.82				
3156.688	200Z	100	31669.60	-0.10	3131.812	400Z	31921.15		0.00		10532 ₄ —42453 ₄
3156.48	20	2	31671.69	-0.09	3130.40	3	31935.54				
3154.64	2		31690.16		3129.588	80	31943.83		+0.01		0 ₂ —31943 ₂
3153.52	3		31701.42		3128.760	100	31952.28		+0.03		0 ₂ —31952 ₁
3152.952	30	6	31707.13	-0.10	3127.390	10	31966.28		+0.05		16163 ₂ —48129 ₁
3152.841	7		31708.24		3126.95	5	31970.78				
3152.59	20	2	31710.77	-0.03	3126.655	40	31973.79		0.00		8983 ₂ —40957 ₂
3151.962	8		31717.09	+0.02	3124.89	1	31991.85				
3151.64	80Z	20	31720.33	-0.05	3124.510	20	31995.74				
3150.332	15	1	31733.50	-0.05	3123.973	1	32001.24				
3149.824	15	1	31738.61	-0.02	3123.68	1	32004.24				
3149.064	20	2	31746.27	-0.03	3123.51	1	32005.99				
3148.898	5		31747.95	-0.01	3122.948	10	32011.75		+0.04		18381 ₃ —50393 ₄
3148.415	100Z	40	31752.82	-0.10	3122.55	2	32015.83		+0.06		16163 ₂ —48179 ₂
3148.10	3		31755.99	-0.13	3122.322	7	32018.16				

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Intensity	Tube	Intensity	Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity	Wave number cm ⁻¹	Wave number cm ⁻¹
3120.645	15	1	32035.37	+0.09	14740 ₂ —46775 ₃	3100.792	1	32240.47	-0.05	14740 ₂ —46984 ₂	
3119.980	100Z	20	32042.20	-0.02	4567 ₄ —36609 ₃	3100.47	2	32243.82	-0.08	16163 ₂ —48404 ₂	
3119.31	2		32049.08		3098.59	1		32263.38			
3119.24	1		32049.80	-0.05	3098.482	3		32264.50	-0.08	15673 ₃ —47937 ₂	
3118.77	4		32054.63	+0.06	3097.602	3		32273.67	+0.01	10508 ₂ —42782 ₁	
3118.63	2		32056.07	-0.07	3096.764	40		32282.40	0.00	4567 ₄ —36850 ₄	
3118.33	10		32059.15		3095.186	4		32298.86	-0.06	18381 ₃ —50680 ₃	
3116.506	30		32077.91	+0.06	3091.397	40		32338.45	0.00	10532 ₄ —42817 ₄	
3116.19	1		32081.17		3090.516	20		32347.67	{ 0.00	14435 ₂ —46782 ₁	
3114.896	15		32094.49		3090.170	30		32351.29	{ +0.01	19222 ₃ —511640 ₄	
3114.56	2		32097.95	-0.14	19292 ₃ —51390 ₂	3089.527	7	32358.02		14740 ₂ —47092 ₁	
3114.059	1		32103.12	+0.07	19292 ₃ —51395 ₃	3089.39	1	32359.45			
3113.447	7		32109.43		3088.985	4		32363.70			
3112.82	1		32115.90		3088.533	60		32368.43	-0.05		
3111.99	1		32124.46		3087.947	8		32374.58	0.00		
3109.852	4		32146.55	+0.02	16163 ₂ —48309 ₁	3087.196	60	32382.45			
3108.63	2		32159.18		3086.580	2		32388.91	-0.08		
3108.043	10		32165.26	-0.01	14017 ₁ —46183 ₂	3085.17	2	32403.72			
3107.91	2		32166.63		3084.743	20		32408.20	+0.04		
3106.93	1		32176.78		3083.628	30		32419.92	0.00		
3106.75	1		32178.64		3083.151	15		32424.93	-0.03		
3106.51	2		32181.13		3083.085	8		32425.63	+0.01		
3106.43	1		32181.96		3082.526	7		32431.51	+0.05		
3106.01	2		32186.31		3082.14	6		32435.57	-0.07		
3105.51	2		32191.49		3081.844	7		32438.68	-0.02		
3104.822	10		32198.62		8983 ₂ —41193 ₁	3080.842	50	32449.23	+0.01		
3103.712	50	1	32210.14	-0.06	10508 ₂ —42719 ₂	3080.27	4	32455.26			
3103.66	20		32210.68	-0.02	19292 ₃ —51503 ₂	3078.77	6	32471.07			
3103.19	1		32215.56	-0.12	3078.04	2		32478.77	-0.11		
3102.391	8		32223.85		3077.76	2		32481.73			

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification			
	Intensity	Tube	Intensity	Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification	Wavelength air (Å)	Intensity	Tube	Spark				
3076.885	30	1	3075.874	20	1	32490.96	32501.64	-0.01	16766 ₄ —49268 ₄	3051.30	10	32763.39	+0.06	14541 ₃ —47304 ₂
3075.315	40	7	3074.789	100Z	40	32507.55	-0.03	10508 ₂ —43016 ₂	3051.16	5	32764.89	-0.09	14017 ₁ —46782 ₁	
3074.104	60Z	20	32520.36	0.00	32513.11	0.00	5638 ₂ —38151 ₁	3050.760	300Z	80	32769.19	0.00	5638 ₂ —38407 ₃	
3073.48	10	100	3072.881	400Z	20	32526.96	+0.12	14435 ₂ —46961 ₂	3047.492	20	32804.33	+0.06	14541 ₃ —47345 ₃	
3072.365	30	10	3071.77	10	10	32533.30	-0.02	0 ₂ —32533 ₃	3046.68	1	32813.07			
3070.85	1		3069.804	2		32538.76	0.00	25084 ₂ —57622 ₂	3045.40	2	32826.86			
3070.498	15		3069.726	7		32545.06	-0.03	16163 ₃ —48708 ₂	3045.28	1	32828.15	+0.08	16163 ₃ —48991 ₂	
3070.095	20		3069.213	15	15	32554.81	+0.06	19292 ₃ —51847 ₃	3044.103	20	32840.84	+0.01	8983 ₂ —41824 ₃	
3068.18	15	1	3067.614	60	10	32558.55	+0.10	18270 ₆ —50828 ₁	3043.905	10	32842.98	+0.05	14017 ₁ —46860 ₂	
3067.426	200Z		3066.18	30	1	32562.82	-0.03	15673 ₃ —48236 ₁	3043.30	3	32849.51	+0.07	14740 ₂ —47590 ₃	
3063.778	80Z		3069.213	15	15	32565.91		32566.73	3042.552	15	32857.59			
3060.18	1		3059.343	10		32572.18	+0.03	10532 ₄ —43104 ₃	3042.271	20	32860.62			
3058.77	1		3058.61	3		32583.14	-0.02	16163 ₂ —48746 ₃	3042.085	30Z	4	32862.63	-0.02	6572 ₁ —39435 ₂
3058.31	2		3057.59	7		32589.15		3041.41	9			32869.92	+0.05	14435 ₂ —47304 ₂
3057.010	400Z		3056.702	20	2	32591.15	-0.12	2356 ₃ —34947 ₂	3041.004	2	32874.31	+0.13	14435 ₂ —47309 ₂ [?]	
3055.74	1		3052.75	1		32604.40	-0.03	14740 ₂ —47345 ₂	3039.647	15	32888.99	+0.06	14092 ₁ —46981 ₂	
3052.100	100		32629.96	+0.01		32629.96		5521 ₀ —38151 ₁	3039.025	7	32895.72			
32663.32			32663.32			32663.32		3038.666	15	1	32899.60	+0.03	14740 ₂ —47640 ₁ [?]	
32677.26			32677.26	+0.01		32677.26		3037.63	6		32910.82	+0.01	14435 ₂ —47345 ₃	
32683.38			32683.38			32683.38		3037.28	30		32914.62			
32685.09			32685.09	-0.09		32685.09		3036.773	10	1	32920.11	0.00	14017 ₁ —46937 ₁	
32688.29			32688.29			32688.29		3034.556	30	3	32944.16	+0.01	14017 ₁ —46961 ₂	
32695.99			32695.99			32695.99		3034.21	7		32947.92	+0.09	18143 ₁ —51091 ₁	
32702.19			32702.19	-0.01		32702.19		3032.48	10		32966.71			
32705.49			32705.49			32705.49		3031.790	20		32974.22	+0.03	15673 ₃ —48647 ₃ [?]	
32737.21			32737.21			32737.21		3031.566	3		32976.65			
32747.83			32747.83	-0.12		32747.83		3030.36	1		32989.78			
								3029.446	20	1	32999.73	-0.02	14092 ₁ —47092 ₁ [?]	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6	
Wavelength air (Å)	Intensity Tube	Intensity Spark	Wavelength cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Tube	Intensity Spark	Wavelength cm ⁻¹	Wave number cm ⁻¹	Classification	
3028.111	4		33014.28	+0.05	1838I ₃ —51395 ₃	3003.287	10		33287.15	-0.03	14017 ₁ ⁱ —47304 ₂	
3026.61	2		33030.65	+0.03	8983 ₂ —42036 ₁	3002.90	20	1	33291.44	-0.05	14017 ₁ ⁱ —47309 ₁	
3024.592	50	4	33052.69	+0.06	20784 ₁ —53853 ₆	3002.46	4		33296.32			
3023.118	10		33068.80	+0.02	8983 ₂ —42075 ₂	3000.82	2		33314.51			
3020.99	10		33092.09	+0.02		3000.464	6		33318.47	+0.10	8983 ₂ —42302 ₂	
3020.530	300Z		100	33097.13	-0.01	2356 ₃ —35453 ₃	2999.523	20		33328.92		
3020.01	1					2999.32	2		33331.17	-0.07	18224 ₄ ⁱ —51556 ₃	
3019.78	2					2998.44	1		33340.95	+0.14	14740 ₂ ⁱ —48081 ₂ ^{??}	
3019.37	1					2996.278	6		33365.01	+0.04	18143 ₁ ⁱ —51508 ₂	
3018.30	250Z	70				2995.76	1		33370.78			
3017.80	2					2994.43	1		33385.60			
3017.36	30	4				2994.036	8		33389.99	-0.07	1838I ₃ ⁱ —51771 ₂	
3016.80	200Z	50				2993.86	2		33391.96			
3016.69	150Z	40				2993.647	3		33394.33			
3016.28	2					2993.011	3		33401.43	+0.01	1838I ₃ ⁱ —51782 ₂	
3015.90	1					2992.074	30	5				
3014.84	10					2991.756	2		33411.89	-0.03	8983 ₂ —42395 ₃	
3014.10	1					2990.228	4		33415.44	+0.08	18224 ₄ ⁱ —51640 ₄	
3010.97	3					2989.76	1		33432.51	-0.02	14436 ₂ ⁱ —47867 ₂	
3010.251	4					2989.46	8		33437.75			
3009.86	10	1				2988.576	5		33441.10			
3007.49	3					2987.62	5		33450.99			
3007.03	2					2987.244	7		33461.70	-0.08	14435 ₂ ⁱ —47896 ₃	
3006.83	1					2986.74	1		33465.91	-0.02	1838I ₃ ⁱ —51847 ₃	
3006.39	10					2985.938	2		33471.56			
3005.84	10					2985.80	1		33480.55	+0.01	14541 ₃ ⁱ —48022 ₄	
3005.556	300Z	100				2984.456	7					
3004.337	3					2984.058	50Z	10				
3004.06	20					2982.727	40					
3003.62	2					2982.56	3					

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
2982.43	10		33519.92			2955.64	4		33823.74		
2981.81	1		33526.89			2954.53	6		33836.44	+0.05	18011 ₂ —51847 ₃
2981.43	1		33531.17			2954.201	500Z	100	33840.21	+0.05	4567 ₄ —38407 ₃
2980.815	500Z	100	33538.08	-0.06	0 ₂ —33538 ₂ ⁰	2953.36	1		33849.85	+0.01	14011 ₁ —47867 ₂
2979.934	4		33548.00	+0.02	14092 ₁ —47640 ₁	2953.12	1		33852.60		
2979.288	100Z	30	33555.27	-0.04	5638 ₂ —39193 ₃	2951.900	20	5	33866.59	+0.03	10508 ₂ —44375 ₂
2977.109	6		33579.83			2950.67	600Z	100	33880.71	+0.05	2356 ₃ —36237 ₃
2976.394	10		33587.90	-0.02	16766 ₄ —50354 ₃	2949.81	5		33890.58		
2973.390	100Z	30	33621.83	-0.08	6572 ₁ —40194 ₂	2948.390	6		33906.90	+0.06	14740 ₂ —48647 ₃
2973.058	20		33625.59			2947.72	2		33914.61		
2972.805	4		33628.45	-0.06	16163 ₂ —49791 ₃	2947.474	2		33917.44	+0.02	14541 ₃ —48454 ₂
2972.00	2		33637.56	+0.10	14541 ₃ —48179 ₂	2944.71	200Z	40	33949.28	0.00	0 ₂ —33949 ₃
2971.24	1		33646.16			2943.70	2		33960.92		
2970.486	4		33654.70			2942.73	10		33972.12	-0.01	14435 ₂ —48407 ₂
2968.338	10		33679.05	-0.03	14541 ₃ —48220 ₄	2940.762	800Z	100	33994.85	-0.01	0 ₂ —33994 ₂
2967.98	1		33683.11			2938.656	2		34019.21		
2967.85	5		33684.59	-0.02		2938.235	4		34024.09	+0.13	14435 ₂ —48459 ₂
2966.953	150Z	30	33694.77	-0.01	14011 ₁ —47702 ₂	2936.338	2		34046.07		
2966.054	7		33704.98	+0.01	6572 ₁ —40267 ₂	2935.725	10		34053.18	+0.03	14541 ₃ —48594 ₂
2965.46	1		33711.74		18224 ₄ —51929 ₅	2935.365	40Z	2	34057.35	+0.02	14541 ₃ —48598 ₃
2964.885	400Z	80	33718.27	-0.09	2356 ₃ —36075 ₄	2934.641	20	1	34065.75	-0.04	5638 ₂ —39704 ₂
2963.97	1		33728.68			2930.69	4		34111.68	-0.09	14011 ₁ —48129 ₁
2963.90	1		33729.48			2929.895	200Z	50	34120.93	-0.03	8983 ₂ —43104 ₃
2963.547	5		33733.50	+0.09	14011 ₁ —47751 ₀	2928.980	40	6	34131.59	+0.01	6572 ₁ —40704 ₁
2962.921	2		33740.62	+0.05	17901 ₅ —51641 ₆	2927.65	3		34147.10		
2962.592	1		33744.37			2926.58	7		34159.58	-0.11	14435 ₂ —48594 ₂
2960.180	5		33771.86			2926.22	10		34163.78	-0.09	14435 ₂ —48598 ₃
2958.55	4		33790.47			2925.965	10		34166.76	-0.02	14541 ₃ —48708 ₂
2958.01	300Z	40	33796.64	+0.06	5638 ₂ —39435 ₂	2924.613	150Z	20	34182.55	-0.08	5521 ₀ —39704 ₁
2956.376	30	1	33815.32	+0.06	14541 ₃ —48356 ₄	2922.15	4		34211.36	+0.05	14740 ₂ —48951 ₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
Tube	Spark					Tube	Spark				
2918.59 ₁	300Z	40	34253.08	-0.10	2356 ₃ —3660 ₉ ₃	2891.89	2		34569.33		
2917.30 ₈	8	34268.14	+0.03	14541 ₃ —4880 ₉ ₃	2891.46	1		34574.47	+0.05	10508 ₂ —4508 ₃ ₃	
2916.48	800Z	100	34277.87	+0.06	4567 ₄ —3884 ₅ ₃	2891.019	40		34579.74	+0.07	10532 ₄ —4511 ₂₃
2915.72	1	34286.81			2889.62	300Z	50		34596.48	+0.01	0 ₂ —34596 ₁
2915.27	5	34292.10	+0.03	14017 ₁ —4830 ₉ ₁	2888.63 ₃	8		34608.30			
2915.08	5		34294.33			2887.54 ₂	100Z	30	34621.38	-0.02	6572 ₁ —4119 ₃ ₁
2913.64	2	34311.28	-0.11	14435 ₃ —4874 ₆ ₃	2887.13 ₂	200Z	60	34626.29	+0.01	4567 ₄ —3919 ₃ ₃	
2913.56	5	34312.23			2884.12	1		34662.45			
2911.83 ₆	2	34332.54			2883.02	1		34675.68			
2910.46	1	34348.77			2882.57	1		34681.09	-0.11	15673 ₃ —5035 ₄ ₃	
2907.31 ₈	3		34385.89			2882.25 ₉	15		34684.83		
2907.01 ₂	30	1	34389.51	+0.07	14017 ₁ —4840 ₇ ₂	2880.84	1		34701.92		
2905.17	5	34411.31	+0.05	15673 ₃ —5008 ₄ ₂	2879.41 ₈	2		34719.05			
2904.76 ₀	300Z	60	34416.17	0.00	2356 ₃ —3677 ₂ ₂	2878.66	10		34728.20		
2904.41 ₂	400Z	70	34420.29	+0.08	4567 ₄ —3898 ₇ ₄	2877.18	80Z	7	34746.06	+0.02	10508 ₂ —4523 ₄ ₂
2902.81	10		34439.29			2874.82	1		34774.58		
2902.64 ₁	30	1	34441.29	+0.02	14017 ₁ —4845 ₉ ₂	2874.48 ₆	1		34778.62		
2901.92 ₅	10	34449.79	+0.03	14541 ₃ —4899 ₁ ₂	2873.63 ₂	50		3	34788.96	+0.02	10532 ₄ —4532 ₄ ₁
2901.16	4	34458.87			2872.73 ₀	4		34799.88			
2900.75 ₀	20	34463.74	+0.04	14541 ₃ —4900 ₅ ₄	2872.48 ₀	10		34802.91	+0.06	8983 ₂ —4378 ₆ ₁	
2900.12	1		34471.23	-0.07	14435 ₂ —4890 ₆ ₂	2872.24 ₆	2		34805.74	+0.10	14541 ₃ —4934 ₇ ₃
2898.25 ₆	500Z	50	34493.40	+0.04	2356 ₃ —3685 ₀ ₄	2871.72	2		34812.12		
2897.11	1	34507.04			2868.95 ₀	4		34845.73			
2896.26 ₀	10Z	3	34517.17	+0.00	16163 ₂ —50680 ₃	2868.10 ₇	15		34855.97	+0.01	10568 ₂ —4536 ₄ ₃
2894.84 ₀	30	3	34534.10	+0.12	8983 ₂ —4351 ₇ ₂	2867.70	60Z	7	34860.92	+0.04	8983 ₂ —4384 ₄ ₁
2893.75 ₁	10		34547.10	+0.05	14435 ₂ —48982 ₁	2867.06	2		34868.70		
2893.03	2	34555.71	-0.13	5638 ₂ —4019 ₄ ₂	2866.37 ₃	500Z	100	34877.06	+0.02	0 ₂ —34877 ₃	
2892.98	3	34556.30	0.00	14435 ₂ —48991 ₂	2865.42 ₂	3		34888.63	+0.02	14017 ₁ —48906 ₂	
2892.56 ₅	60Z	7	34561.26	0.00	6572 ₁ —4113 ₃ ₀	2865.05 ₄	1		34893.11	-0.03	14092 ₁ —48985 ₆
2891.95 ₄	3					2864.72 ₂	9		34897.15	+0.01	14541 ₃ —49438 ₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6	
Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Classification		Wave- length air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	
	Tube	Spark					Tube	Spark				
2863.64	4	4	34910.34	+0.04	15673 ₃ —50583 ₃	2837.96	2		35226.22			
2863.41	60Z	60Z	34913.14	-0.02	2356 ₃ —37269 ₄	2837.55	1		35231.31			
2862.632	20	1	34922.63	+0.04	10532 ₄ —45455 ₃	2836.82	2		35240.37	+0.10	14740 ₂ —49980 ₃	
2860.558	100Z	15	34947.95	0.00	0 ₂ —34947 ₃	2836.13	3		35248.95			
2859.97	1		34955.14			2836.028	2		35250.22	+0.02	14541 ₃ —49791 ₃	
2859.66	1		34958.92			2834.130	60Z	10	35273.82	-0.01		
2859.103	6		34965.73	0.00	10508 ₃ —45474 ₁	2833.285	150Z	20	35284.34	+0.02		
2855.997	2		35003.76	+0.07	14435 ₃ —49438 ₂	2831.934	1		35301.17			
2855.828	5		35005.83			2830.985	2		35313.01			
2855.30	1		35012.30			2830.511	20	1	35318.92	0.00	5638 ₂ —40957 ₂	
2854.565	1		35021.32			2829.08	2		35336.78			
2854.168	1		35026.19			2828.49	4		35344.15			
2853.757	2		35031.23			2828.430	3		35344.90	-0.11		
2850.967	100Z	20	35065.51	{ 0.00	5638 ₂ —40704 ₁	2828.078	2		35349.30			
2849.648	10		35081.74	{ 0.00 -0.02	(8983 ₂ —44049 ₃) 14541 ₃ —49623 ₄	2827.27	1		35359.40			
2847.656	3		35106.28			2824.50	1		35394.08			
2847.21	1		35111.78	-0.07		2823.40	2		35407.87			
2846.829	1		35116.48			2822.355	5		35420.98	-0.02		
2846.633	9		35118.90	0.00	14541 ₃ —49660 ₃	2820.664	2		35442.21			
2845.832	200Z	20	35128.78	-0.04	5683 ₂ —40767 ₃	2819.746	100Z	15	35453.75	-0.07	0 ₂ —35453 ₃	
2845.57	2		35132.02			2819.194	3		35460.69			
2845.11	3		35137.70			2818.942	60Z	5	35463.86	0.00		
2844.890	10		35140.41	-0.07		2818.00	2		35475.72			
2843.530	30	1	35157.22	-0.06	10508 ₂ —45649 ₃	2817.685	100Z	10	35479.68	-0.09	8983 ₂ —44463 ₃	
2843.10	3		35162.54	0.00	10508 ₃ —45666 ₂	2815.815	50	2	35503.24	-0.03	6572 ₁ —42075 ₂	
2842.773	2		35166.58		17901 ₅ —53063 ₄	2812.326	40	3	35547.29	-0.02	10508 ₃ —46056 ₂	
2841.493	70Z	7	35182.42	+0.07	5521 ₀ —40704 ₁	2811.692	10		35555.30	-0.03	5638 ₂ —41193 ₁	
2840.387	15	1	35196.12	-0.01	6572 ₁ —41768 ₃	2810.78	2		35566.84			
2838.65	1		35217.66			2809.39	2		35584.43			
2838.02	2		35225.47			2808.80	2		35591.91	+0.01	10508 ₂ —46100 ₁	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length-air (Å)	Intensity		Classification		Wavelength-air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
	Tube	Spark				Tube	Spark				
2808.60	1		35594.44		2782.465	15		35928.75		-0.10	10508 ₂ —46437 ₂
2807.506	10		35608.31	+0.10	2781.53	2		35940.83			
2806.30	2		35617.27		2781.421	2		35942.24			
2806.624	6		35619.50	-0.07	2780.938	2		35948.48			
2806.275	3		35623.93	-0.05	2779.370	150Z	30	35968.76		-0.02	2356 ₃ —38325 ₂
2805.745	2		35630.66		2778.884	4		35975.05			
2803.48	3		35639.45		2778.40	1		35981.32			
2803.29	1		35661.86		2776.62	2		36004.38			
2802.479	50	2	35672.18	+0.01	2776.26	3		36009.05			
2802.106	6		35676.93		2773.021	60	10	36051.11		-0.01	2356 ₃ —38407 ₃
2801.426	20		35685.59	-0.07	2771.328	3		36073.13			
2800.652	1		35695.45		2770.94	1		36078.18			
2799.93	1		35704.66		2767.09	9		36128.38		-0.10	8983 ₂ —45112 ₃
2797.980	10		35729.54	-0.03	2766.966	80Z	10	36130.00		-0.06	5638 ₂ —41768 ₂
2796.951	1		35742.68		2766.301	3		36138.68		-0.08	14541 ₃ —50680 ₃
2795.826	3		35757.06	-0.07	10532 ₄ —46218 ₃			36155.06		-0.08	8983 ₂ —45138 ₃
2795.747	3		35758.07	-0.05	10532 ₄ —46289 ₄			36172.95			
2795.093	3		35766.44		2763.68	2		36174.08			
2794.703	10		35771.43	+0.02	2763.594	1		36175.40		-0.03	140117 ₁ —50193 ₂
2793.762	5		35783.48		2763.493	3		36185.94		-0.03	5638 ₂ —41824 ₃
2792.659	3		35797.61		2761.78	10		36197.84			
2792.309	3		35802.10		2761.634	200Z	20	36199.75		-0.04	4567 ₄ —40767 ₃
2791.73	1		35809.52		2760.006	1		36221.10			
2791.338	3		35814.55	-0.08	2759.635	2		36225.97			
2788.460	3		35851.51	-0.04	2758.771	80Z	10	36237.32		-0.02	0 ₂ —36237 ₃
2788.42	1		35852.03		2758.314	40		36243.32		-0.08	10532 ₄ —46775 ₃
2787.211	10		35867.58		2757.72	1		36251.13			
2785.874	2		35884.79		2757.633	2		36252.27			
2784.10	1		35907.66		2755.991	10		36273.87		-0.03	10508 ₂ —46782 ₁
2783.698		60Z			35912.84	-0.11		36278.15		2	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength-air (Å)	Intensity		Wave number cm ⁻¹	Classification		Wavelength-air (Å)	Intensity		Wave number cm ⁻¹	Classification	
Tube	Spark		cm ⁻¹			Tube	Spark		cm ⁻¹		
2754.552	1		36292.82	15673 ₃ —51968 ₄	2730.700	50Z	5	36609.81	-0.05	0 ₂ —36609 ₃	
2754.368	1		36295.24	-0.03	2730.13	2		36617.45			
2754.219	2		36297.20	-0.02	2729.88	1		36620.81			
2753.83	3		36302.33		2729.376	7		36627.57			
2752.53	3		36319.48		2729.098	40Z	5	36631.30	+0.13	2356 ₃ —38987 ₄ ?	
2751.243	5		36336.46		2728.10	1		36644.70			
2750.89	1		36341.13		2727.797	1		36648.77			
2750.677	1		36343.94		2727.644	1		36650.82			
2750.252	1		36349.56	-0.12	2726.972	5		36659.85	+0.06	1454I ₃ —50891 ₂ ²	
2749.49	2		36359.63		2726.70	7		36663.51	+0.01	5638 ₂ —42302 ₂	
2748.338	2		36374.87		2722.893	4		36714.77			
2748.111	1		36377.87		2721.90	8		36728.16			
2746.940	2		39393.38	-0.07	2721.462	2		36734.07			
2746.606	40		36397.81	+0.02	2720.91	1		36741.53			
2746.163	1		36403.68		2719.755	10		36757.13	+0.08	5638 ₂ —42395 ₃	
2745.095	1		36417.84		2718.593	50Z	10	36772.84	-0.01	0 ₂ —36772 ₂	
2744.51	1		36425.60		2718.445	30	4	36774.84			
2744.23	1		36429.32		2717.54	1		36787.09	0.00	14092 ₁ —50879 ₂	
2743.637	100Z	20	36437.19	-0.01	2717.36	1		36789.52			
2742.633	7		36450.53		2716.87	7		36796.16	+0.05	10508 ₂ —47304 ₂	
2742.091	20	1	36457.74	0.00	10508 ₂ —46966 ₃	2716.55	1	36800.49	+0.07	10508 ₂ —47309 ₁	
2741.46	1		36466.13		2715.423	3		36815.76	+0.01	8983 ₂ —45799 ₁	
2741.067	3		36471.35	-0.05	2714.06	15	1	36834.25	-0.06	10532 ₄ —47366 ₅	
2737.816	50Z	3	36514.66	+0.03	2713.837	50Z	5	36837.28	+0.04	2356 ₃ —39193 ₃	
2737.150	2		36523.54		2712.96	1		36849.19	+0.08	1454I ₃ —51390 ₄	
2736.024	20	1	36538.57	-0.03	8983 ₂ —45522 ₃	2711.823	40	36864.64	0.00	8983 ₂ —45848 ₂	
2735.638	2		36543.73		2711.595	5		36867.74			
2733.310	2		36574.85		2711.17	2		36873.51			
2732.146	4		36590.43		2709.702	3		36893.49			
2730.86	60	6	36607.66	-0.06	2709.166			36900.79			

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wavelength air (Å)	Intensity		Wave number cm ⁻¹	Wave number cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
2708.652	2		36907.79	-0.12	15673 ₃ —52581 ₄ ⁱ	2688.980	6		37177.78		
2708.154	1		36914.58			2688.360	50	2	37186.36	-0.01	8983 ₂ —46170 ₂
2707.87	8		36918.45			2687.846	5		37193.47	-0.07	10508 ₂ —47702 ₂
2705.612	100Z		36949.26	-0.01	0 ₂ —36949 ₁ ⁱ	2686.88	2		37206.84	0.00	20908 ₂ —58115 ₂
2704.554	15		36963.71	-0.01	5521 ₀ —42485 ₁ ⁱ	2686.547	6		37211.45		
2704.34	2		36966.64	-0.06	14541 ₃ —51508 ₂	2686.360	20	1	37214.04	-0.01	6572 ₁ —43786 ₁ ⁱ
2702.37	1		36993.58			2685.701	4d		37223.17		
2702.004	3		36998.59	0.00	14740 ₂ —51739 ₃ ⁱ	2683.269	80		37256.91	-0.03	4567 ₄ —41824 ₃ ⁱ
2701.545	2		37004.88			2682.180	40	1	37272.03	-0.05	6572 ₁ —43844 ₁ ⁱ
2701.43	1		37006.45			2681.72	4		37278.43		
2700.894	3		37014.62	+0.07	14541 ₃ —51556 ₃ ⁱ	2680.592	1		37294.11		
2700.12	1		37024.41			2679.761	2		37305.68	-0.09	14541 ₃ —51847 ₃ ⁱ
2699.632	70Z	10	37031.10			2679.40	2		37310.70		
2698.82	1		37042.24			2678.925	2		37317.32		
2698.314	2		37049.19			2677.99	1		37330.35	-0.05	20784 ₁ —58115 ₂ ⁱ
2698.054	2		37052.76			2677.914	2		37331.41		
2697.70	9		37057.62	+0.06	10532 ₄ —47590 ₃ ⁱ	2676.426	3		37352.16	0.00	10532 ₄ —47884 ₃ ⁱ
2697.157	1		37065.08			2676.27	1		37354.34		
2696.77	2		37070.40			2675.957	30		37358.71	-0.06	10508 ₂ —47867 ₂ ⁱ
2696.552	8		37073.39	-0.02	14017 ₁ —51091 ₁ ⁱ	2675.47	8		37365.51	-0.03	10508 ₂ —47874 ₁ ⁱ
2696.130	80Z	10	37078.51	0.00	2356 ₃ —39435 ₂ ⁱ	2675.250	10		2h	37368.58	
2694.76	2		37098.05			2674.80	5			37374.87	
2694.460	1		37102.18			2673.78	1			37389.12	
2694.058	3		37107.71			2673.542	1			37392.45	
2693.80	2		37111.27			2673.191	2			37397.36	
2693.082	2		37121.16	+0.07	14435 ₃ —51556 ₁ ⁱ	2673.060	5			37399.19	-0.11
2691.04	1		37149.33			2673.007	9			37399.93	
2690.656	1		37154.63			2672.454	1			37407.67	
2690.319	7		37159.28			2672.122	3			37412.32	+0.01
2689.322	3		37173.06			2671.721	40	1		37417.94	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Wave-number cm ⁻¹	Classification
	Tube	Spark	Intensity	Tube	Spark	Intensity	Tube	Spark	Intensity	Tube	cm ⁻¹	
2671.022	2		37427.73	2643.886		1	2642.751		37811.85	37828.09	+0.07	4567 ₄ —42395 ₃
2670.895	6		37429.51	2642.076		2	2640.829		37837.75	37855.62	-0.02	2356 ₃ —40194 ₃
2670.76	2		37431.40	2640.121		1	2640.121		37865.77			
2670.638	1		37433.11									
2669.924	2		37443.12									
2668.290	90Z	6	37466.05	2639.960		3	2639.183		37868.08	37879.23	+0.02	5638 ₂ —43517 ₃
2665.051	9		37511.58	2639.183		40	2637.853		37898.32	37903.25	-0.05	10508 ₂ —48407 ₂
2664.786	5		37515.31	2637.853		15	2637.510		37903.25	37910.63	-0.01	2356 ₃ —40267 ₂
2664.583	1		37518.17	2636.997		2	2636.997		37910.63			
2664.02	6	2h	37526.09	2636.686		5	2635.570		37915.10	37931.15	-0.03	6572 ₁ —44503 ₂
2663.717	10		37530.36	2635.104		4	2635.104		37937.86	37947.64	-0.01	10508 ₂ —48049 ₃
2663.572	3		37532.41	2634.425		3	2634.425		37947.64	37950.19	-0.01	10532 ₄ —48081 ₃
2662.994	30		37540.55	2634.248		20	2634.248		37950.19			
2662.396	15		37548.98	2633.504		30	2633.504					
2661.15	20		37566.56	2633.42			2633.42					
2659.130	5		37595.10	2632.737		2	2632.737					
2656.95	2		37625.94	2630.907		2d	2630.907					
2655.657	3		37644.26	2630.34		1	2630.34					
2655.03	3		37653.15	2629.983		100	2629.983					
2654.30	1	2h	37663.51	2629.756		2	2629.756					
2653.826	30		37670.23	2628.353		1	2628.353					
2652.781	50Z	1	37685.07	2627.720		3	2627.720					
2651.785	3		37699.23	2626.081		1	2626.081					
2650.737	1		37714.13									
2650.022	2		37724.30									
2649.864	3		37726.55	2624.79		60	2624.79		38086.92	38090.03	-0.01	8983 ₂ —47070 ₃
2649.440	4		37732.59	2624.576		5	2624.576		38093.92	38099.76	-0.08	10508 ₂ —48598 ₃
2649.397	2		37733.20	2624.308		2	2624.308		38099.76	38103.26		
2645.262	20		37792.18	2623.906		3	2623.906					
2643.999	15		37810.23	2623.665		4	2623.665					

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Intensity	Tube	Intensity	Spark	Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification	Wavelength air (Å)	Intensity	Wave number cm ⁻¹	Wave number o-c cm ⁻¹
2623.318	40	1	38108.29	+0.02	8983 ₂ —47092 ₁	2599.39	3	38459.07	4567 ₄ —43104 ₃		
2620.772	10		38145.31		2598.804	1		38467.74			
2620.590	20	2	38147.96	-0.02	5638 ₂ —43786 ₁	2598.432	2	38473.25	10508 ₃ —48982 ₁	-0.04	
2620.466	3		38149.77		2597.811	15		38482.44	10508 ₂ —48991 ₂	-0.10	
2620.33	1		38151.75	+0.03	0 ₂ —38151I ₁	2597.522	2	38486.73			
2619.46	2		38164.42		2595.807	3		38512.15			
2618.424	2		38179.52		2594.131	50	2	38537.03	-0.03		
2617.804	5		38188.56		2593.458	5		38547.03			
2617.15	3		38198.10		2592.162	10		38566.30	-0.04		
2617.048	4		38199.59	+0.03	10508 ₂ —48708 ₂	2589.842	10	38600.85	0.00		
2616.606	80Z	8	38206.04	+0.03	5638 ₂ —43844 ₁	2589.776	5	38601.83			
2612.585	40Z	1	38264.84	+0.02	5521 ₀ —43786 ₁	2589.472	15	38606.36	-0.01		
2611.617	3		38279.02		2588.668	3		38618.35			
2611.340	30	1	38283.08		2588.536	4		38620.32			
2610.742	2		38291.85		2587.674	1		38633.19			
2609.959	40	4	38303.34	-0.02	4567 ₄ —4287I ₄	2587.49	2	38635.93			
2609.713	2		38306.95		2586.72	3		38647.43			
2609.559	1		38309.21		2586.118	30		38656.43	-0.07		
2609.13	2		38315.51		2585.697	2		38662.72			
2608.628	30	1	38322.88	+0.03	5521 ₀ —43844 ₁	2585.552	2	38664.89			
2608.450	60Z	5	38325.50	+0.04	0 ₂ —38325 ₂	2585.268	1	38669.14			
2606.018	20		38361.26	-0.10	8983 ₂ —47345 ₂	2585.068	1	38672.13			
2603.92	3		38392.17		2584.411	2		38681.96			
2603.555	8		38397.55	+0.01	10508 ₂ —48906 ₂	2582.982	3	38703.36			
2603.404	2		38399.78		2582.786	10		38706.30			
2602.863	30	2	38407.76	-0.04	0 ₂ —38407 ₃	2581.924	3	38719.22			
2602.663	60	3	38410.71	{-0.04 +0.07}	2356 ₃ —40767 ₃ 5638 ₂ —44049 ₃	2580.820	20	38735.78	{-0.02 +0.08}		
2601.842	8		38422.83		2579.752	1		38751.82			
2600.736	2		38439.17		2576.410	2		38802.08			
2600.230	2		38446.65		2574.896	50Z	2	38824.89	-0.01		

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	Classification	Intensity		Wavelength air (Å)	Wave number o-c cm ⁻¹	Wave number o-c cm ⁻¹	Classification
							Tube	Spark				
2571.775	30					10532 ₁ —49389 ₅	2549.53	1	39211.15	39226.56		
2572.24	2					5638—44503 ₃	2548.528	10	39237.74	39265.82		
2570.395	8					8983 ₂ —47876 ₁	2547.802	3	39275.85	+0.01	6572 ₁ —45848 ₂	
2569.860	20					8983 ₂ —47884 ₃	2547.98	2				
2568.69	2					38918.69	2545.330	60				
2567.950	15					38929.90	—0.03		39282.94	—0.04		
2567.418	20					38937.97	+0.02		39286.80			
2567.288	7					38939.94			39325.44			
2567.05	2					38943.55			39345.63			
2566.351	8					38954.16	0.00		39353.02			
2566.244	10					38955.78			39373.76			
2565.90	8					38961.00	+0.09		39385.14			
2565.194	15					38971.73			39403.01			
2564.386	6					38984.00			39427.70			
2562.448	2					39013.49			39435.18	—0.01		
2561.30	20					39030.97			39439.40			
2560.372	1					39045.12			39446.93			
2559.834	2					39053.32			39452.60			
2559.018	60	2				39065.78	+0.02		39457.67			
2558.21	6					39078.11			39467.95	+0.05		
2557.41	2					39090.34			39473.59	—0.02		
2556.924	20					39097.77	+0.03		39480.73			
2555.05	10					39126.44			39483.54			
2554.31	1					39137.77			39486.81			
2553.89	2					39144.21			39520.78			
2553.402	10					39151.69	+0.01		39527.25			
2552.66	2					39163.07			39547.11			
2550.73	2					39192.70			39553.99			
2550.46	1					39196.85			39572.68			
2549.93	1					39205.00			39597.70	+0.13		

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification	
	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification <i>x</i>	Wave length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	
2523.79	3			39611.03			2497.730	8		40024.29		
2523.552	2			39614.77			2496.818	30		40038.90	-0.08	2356 ₃ —42395 ₃
2522.85	3			39625.79			2496.058	40		40051.09	+0.02	10532 ₄ —50583 ₃
2522.749	1			39627.38			2495.675	1		40057.24		
2522.220	3			39635.69			2494.74	2		40072.25		
2521.695	10			39643.94			2493.61	1		40070.41		
2520.41	8			39664.15			2493.06	5		40099.25		
2518.36	1			39696.44			2491.871	2		40118.39		
2517.858	30Z			39704.35	-0.05		2491.64	1		40122.11		
2517.52	15			39709.68			2491.156	2		40129.90		
2511.36	5			39807.08			2491.058	3		40131.48		
2510.76	3			39816.59	+0.06		2490.650	2		40138.05		
2509.892	3			39830.36			2489.892	2		40150.27		
2509.790	2			39831.98			2489.236	15		40160.85	-0.03	5638 ₂ —45799 ₁
2508.038	2			39859.80			2488.867	6		40166.81		
2506.535	9			39883.70	-0.03		2488.14	4		40178.54		
2503.28	1			39935.55			2487.153	60		40194.48	+0.03	
2502.97	2			39940.50			2485.555	20		40220.32	-0.05	0 ₂ —40194 ₂
2502.663	50			39945.40	-0.03		2485.354	3		40223.58		8933 ₂ —49204 ₁
2502.25	2			39951.99			2484.990	10		40229.47		
2501.702	1			39960.74			2482.934	15		40262.78		
2501.32	4			39966.85			2482.647	40		40267.43	+0.11	0 ₂ —40266 ₂
2501.234	10			39968.22	-0.02		2482.010	20		40277.77	+0.05	5521 ₀ —45799 ₁
2501.130	20			39969.88	+0.03		2480.57	1		40301.15		
2500.178	1			39985.10			2479.76	1		40314.31		
2500.096	2			39986.41			2479.428	20		40319.71	+0.02	105088 ₂ —50828 ₁ ?
2499.825	20			39990.75			2479.076	3		40325.43	+0.07	10532 ₄ —50357 ₃
2499.32	1			39998.83			2476.36	3		40369.66		
2498.168	1			40017.27			2476.30	1		40370.63		
2497.914	3			40021.34			2475.573	9		40382.49	+0.03	10508 ₂ —50891 ₂

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave-length air (Å)	Intensity Tube	Intensity Spark	Wave number cm ⁻¹	
2473.736	4			40412.47	40424.50		2450.080	10		40802.64	
2473.00	1			40426.30	40432.02		2449.053	6		40819.75	
2472.89	1			40442.16	40442.16		2448.624	1		40826.90	
2472.54	6						2447.65	1		40843.14	
2471.92	7						2446.731	7		40858.48	
2471.21	10						2446.248	2		40866.55	
2470.998	20						2444.944	50		40887.51	+ 0.01
2469.965	15						2443.766	6		40908.05	
2468.378	15						2441.920	30		40938.97	0.00
2467.518	6						2441.53	1		40945.51	
2466.665	10						2441.22	1		40950.71	
2466.464	8						2440.814	15		40957.52	- 0.01
2465.676	30						2438.535	9		40995.80	
2465.466	1						2438.316	5		40999.48	0.00
2464.83	1						2437.79	3		41008.33	
2463.725	3						2435.767	2		41042.38	
2463.547	6						2435.472	3		41047.35	+ 0.02
2463.378	3						2434.522	1		41063.37	
2462.926	4						2434.266	2		41067.69	- 0.01
2461.602	3						2433.798	9		41075.58	
2461.12	1						2433.216	2		41085.41	
2458.653	30						2432.303	2		41100.83	- 0.01
2457.871	15						2431.414	5		41115.86	
2456.957	4						2431.152	1		41120.29	
2456.31	1						2430.92	2		41124.21	
2456.061	30						2430.144	20		41137.34	0.00
2455.711	1						2428.740	30		41161.12	- 0.02
2453.013	30						2426.804	9		41193.95	+ 0.01
2451.885	20						2426.52	5		41198.77	
2450.66	1						2424.92	1		41225.96	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification	Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
2422.09	20		41274.12	+0.08	10508 ₂ —51782 ₂	2403.12	8		41599.91	+0.03	8983 ₂ —50583 ₃
2420.554	2		41300.31			2401.522	1		41627.59		6572 ₁ —48259 ₁
2420.08	1		41308.40			2400.325	2		41648.35	-0.02	2356 ₃ —44049 ₃
2419.371	2		41320.50			2399.726	20		41658.74		
2419.17	2		41323.94			2399.144	6		41668.85		
2418.76	1		41330.94			2398.121	10		41686.62	-0.01	
2418.29	1		41338.97			2397.780	20		41692.55	-0.02	
2418.074	2		41342.67	+0.09	5638 ₂ —46981 ₂	2397.565	10		41696.29		
2417.030	4		41360.52			2397.21	2		41702.46		
2416.504	6		41369.52			2396.98	4		41706.46	-0.03	5638 ₂ —47345 ₂
2416.427	15		41370.84	+0.06	8983 ₂ —50354 ₃	2394.973	2		41741.41		
2415.84	4		41380.89	-0.02	8983 ₂ —50364 ₂	2390.794	8		41814.37		
2415.72	5		41382.95			2390.20	4		41824.76		
2415.59	3		41385.18			2388.50	2		41854.52		
2414.045	1		41411.66			2387.38	5		41874.16	-0.01	8983 ₂ —50857 ₃
2413.871	4		41414.65			2386.70	1		41886.09		
2412.85	4		41432.17	+0.11	5638 ₂ —47070 ₃	2386.562	2		41888.51		
2412.622	6		41436.08	+0.04	10532 ₄ —51968 ₄ ^j	2386.014	1		41898.13		
2412.51	7		41438.01	+0.09	2356 ₃ —43794 ₄ ^j	2384.467	15		41925.31		
2412.261	2		41442.28			2382.980	15		41951.47	-0.03	
2411.605	15	3	41453.56	-0.16	5638 ₂ —47092 ₁ ?	2381.51	1	1	41977.36		
2411.425	8		41456.65			2379.716	5		42009.00		
2410.97	3		41464.47			2378.925	4		42022.97		
2409.54	2		41489.08			2378.81	4	3h	42025.00		
2409.140	2		41495.97			2378.513	1		42030.25		
2407.692	20		41520.92			2378.32	1		42033.66		
2407.132	9		41530.58			2378.163	15		42036.44	+0.04	0 ₂ —42036 ₁
2406.051	5		41549.24			2377.98	3		42039.67		
2405.679	3		41555.66			2377.471	4		42048.67	-0.01	10532 ₄ —52584 ₄
2403.296	4		41596.86			2377.237	2		42052.81		

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification	Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
2376.46	1		42066.56			2353.31	1		42480.34		
2375.937	6		42075.82	+0.01	$0_2 - 42075_2^*$	2353.02	10	1	42485.58	+0.09	$0_2 - 42485_1^*$
2374.516	2		42100.99			2352.60	5		42493.16		
2374.186	15		42106.85	+0.02	$2356_3 - 44463_3^*$	2352.04	8		42503.28		
2373.530	8		42118.48	+0.01	$5521_0 - 47640_1^*$	2350.48	2		42531.48		
2373.12	2		42125.76			2349.751	5		42544.68		
2372.23	2		42141.56			2347.88	1		42578.58		
2371.92	6		42147.07	+0.03	$2356_3 - 44503_2^*$	2345.565	2		42620.60	+0.04	$5638_2 - 48259_1^*$
2371.54	3		42153.82			2344.957	8		42631.65	+0.08	$6572_1 - 49204_1^*$
2370.92	2		42164.84			2342.40	2		42678.18		
2370.44	1		42173.38			2342.06	1		42684.38		
2367.20	1		42231.10			2340.59	5		42711.18		
2366.814	8		42237.99	-0.01	$5638_2 - 47787_1^*$	2339.15	3		42737.47	+0.07	$5521_0 - 48259_1^*$
2366.365	9		42246.00	-0.10	$5638_2 - 47884_3^*$	2338.555	7		42748.35		
2365.45	1		42262.34			2337.597	1		42765.86		
2363.39	10		42299.17	-0.12	$5638_2 - 47937_2^*$	2336.693	9		42782.41		
2363.23	8		42302.04	-0.07	$0_2 - 42302_2^*$	2335.772	9		42799.28	+0.06	$4567_4 - 47366_5^*$
2362.546	4		42314.28			2334.10	1		42829.93		
2362.02	1		42323.71			2330.70	5		42892.41		
2361.290	1		42336.79			2326.76	3		42965.03		
2360.29	5		42354.73	-0.11	$5521_0 - 47876_1^*$	2319.54	3		43098.76		
2359.27	3		42373.04			2319.21	4		43104.89		
2359.08	2		42376.45			2315.93	4		43165.93		
2358.90	10		42379.68			2315.32	3		43177.30		
2358.01	8		42395.68	+0.02	$0_2 - 42395_3^*$	2312.82	2		43223.97		
2357.05	3		42412.94	+0.08		2310.92	1		43259.51		
2355.78	3		42435.80			2308.04	2		43313.48	+0.11	$5638_2 - 48951_2^*$
2355.65	2		42438.15			2304.343	6		43382.96		
2355.38	5		42443.01	+0.14		2299.190	5		43480.19	-0.07	$4567_4 - 48047_4^*$
2353.506	1		42476.80			2298.57	1		43491.91		

Appendix B. Observed and Classified Lines of Hf I—Continued

1	Intensity		5		6		Classification	6
	Wave-length air (Å)	Tube	Spark	Wave number cm ⁻¹	Wavelength air (Å)	Intensity	Wave number cm ⁻¹	
2297.71	2			43508.19	2248.95	3	44451.41	
2297.42	1			45313.68	2248.33	1	44463.67	
2294.88	1			43561.84	2246.29	1	44504.05	
2292.77	2			43601.93	2244.24	2	44544.70	
2291.06	2			43634.47	2243.16	5	44566.14	
2289.28	2			43668.39	2240.20	1	44625.02	
2288.551	4			43682.30	2235.635	4	44716.13	
2283.089	5			43786.79	2235.41	1	44720.63	
2282.80	3			43792.34	2235.13	2	44726.23	
2281.683	5			43813.77	2230.35	4	44822.08	
2280.072	4			43844.73	2223.94	1	44951.26	
2279.195	4			43861.60	2221.59	1	44998.80	
2275.483	6			43933.14	2220.48	2	45021.29	
2275.26	1			43937.45	2219.60	1	45039.14	
2274.545	2			43951.26	2219.45	1	45042.19	
2274.18	1			43958.31	2218.45	1	45062.49	
2273.92	3			43963.34	2214.675	2	45139.29	
2271.453	5			44011.08	2211.32	2	45207.77	
2269.86	4			44041.97	2210.05	2	45233.74	
2269.483	3			44049.28	2206.09	6	45314.93	
2268.92	1			44060.21	2204.63	2	45344.94	
2268.686	4			44064.75	2204.17	4	45354.40	
2267.91	2			44079.83	2203.40	1	45370.25	
2267.582	2			44086.21	2202.18	2	45395.38	
2263.37	2			44168.24	2199.84	2	45443.66	
2262.20	1			44191.08	2196.03	4	45522.50	
2262.015	5			44194.70	2195.52	3	45533.07	
2261.54	2			44203.98	2194.968	10	45544.52	
2260.25	2			44229.20	2194.12	1	45562.12	
2258.32	2			44267.00	2193.84	2	45567.94	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2		3		4		5		6		Classification
	Intensity	Tube	Intensity	Spark	Wave number cm ⁻¹	Wave number cm ⁻¹	Classification	Wave number cm ⁻¹	Wave number cm ⁻¹	Wave number cm ⁻¹	
2193.196	4				45581.32	+0.09	2356 ₃ —47937 ₂	2130.98	4	46911.96	
2188.72	1				45674.52			2130.08	2	46931.78	
2188.428	3				45680.61			2138.17	2	46973.89	
2187.91	3				45691.43			2127.50	1	46988.6 ¹	
2187.43	2				45701.45			2123.32	1	47081.18	
2186.29	2				45725.28			2122.81	3	47092.48	
2184.30	3				45766.93			2119.59	2	47164.02	
2182.73	1				45799.85			2118.69	6	47184.05	
2176.41	1				45932.83			2116.80	1	47226.17	
2175.76	2				45946.55			2113.14	3d	47307.96	
2172.77	3				46009.77			2111.84	1	47337.08	
2171.88	3				46028.63			2111.47	1	47345.37	
2165.20	4				46171.62			2111.24	1	47350.53	
2164.06	4				46194.94			2108.98	3	47401.27	
2162.95	3				46218.64			2108.56	2	47410.71	
2161.57	4				46248.15			2108.25	3	47417.68	
2159.57	2				46290.97	+0.14	2356 ₃ —48647 ₂	2106.25	4	47462.70	
2158.10	4				46322.50			2105.20	2	47486.37	
2154.21	3				46406.14			2100.59	1	47590.57	
2153.54	2				46420.57			2094.54	3	47728.02	
2151.67	5				46460.91	+0.17	0 ₂ —46460? ²	2093.22	2	47758.11	
2150.27	3				46491.16			2089.56	2	47841.75	
2150.17	2				46493.32			2089.39	1	47845.64	
2149.83	3				46500.67			2087.67	3	47885.06	
2144.71	1				46611.67			2087.43	3	47890.56	
2142.36	5				46662.79			2085.19	2	47942.00	
2139.86	1				46717.30			2084.59	2	47955.80	
2138.57	3				46745.48			2079.12	1	48081.95	
2137.54	1				46768.00			2076.48	2	48143.07	
2135.65	2				46809.39			2075.95	3	48155.36	

Appendix B. Observed and Classified Lines of Hf I—Continued

1	2	3	4	5	6	1	2	3	4	5	6
Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Classification		Wave-length air (Å)	Intensity		Wave number cm ⁻¹	Wave number o-c cm ⁻¹	Classification
	Tube	Spark					Tube	Spark			
2072.87	2		48226.91	-0.03	2356 ₃ —50533 ₂ ^a	2053.54	2		48680.81		
2071.48	3		48259.26	+0.09	0 ₂ —48259 ₁	2047.84	1		48816.29		
2068.59	3	5?	48326.68			2042.14	3		48952.52		
2065.72	1		48393.81			2031.68	1		49204.52		
2060.48	4		48516.86			2022.59	2		49425.62		
2056.16	1		48618.79			2017.90	1		49540.48		
2055.30	2		48639.13	-0.05	8983 ₂ —57622 ₂ ^b						

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16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

The present publication terminates the work on the analysis of Hf I which was started by the late W. F. Meggers in 1928 and left unfinished in 1966. His final line list contains some 4700 lines of which about 67 percent have been classified. Observed g-values are known for 198 levels. The reliability of the Zeeman observations is indicated in tables containing sums of Observed and Landé g-values for selected groups of "even" and "odd" terms.

An attempt has been made to continue Meggers' analysis in LS-coupling as far as possible. This coupling is not rigorous in Hf I, and many intervals are irregular. Consequently, the levels are given also in numerical order with the even and odd levels presented in separate tables.

An ionization limit of $54700 \pm 600 \text{ cm}^{-1}$, giving an ionization potential of $6.78 \pm 0.07 \text{ eV}$ has been derived from a two-member series.

The long line lists are given in two Appendices: Appendix A contains the observed Zeeman data for the individual lines, 531 in all; Appendix B consists of the complete line list of observed and classified lines.

By far the greater part of the analysis is that Meggers. Detailed notes explain changes that have been introduced and additions to this work.

17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)

Analysis, Hf I spectrum; hafnium, analysis of first spectrum; spectrum, Hf I; Zeeman effect, Hf I.

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