

PRELIMINARY CATALOGUE OF LINES AFFECTED
IN SUN-SPOTSREGION $\lambda 4000$ TO $\lambda 4500$

By WALTER S. ADAMS

INTRODUCTORY NOTE

One of the co-operative investigations set on foot by the International Union for Co-operation in Solar Research was the detailed visual study of the lines affected in sun-spots. The committee in charge of this work concluded that the simplest way to detect possible changes of intensity would be to compare the observed spot lines with the same lines as recorded in a map of the spot spectrum. The preparation of such a map from visual observations would obviously entail much time and labor. For this reason it seemed desirable to make use of the photographs of spot spectra obtained with the Snow telescope at Mount Wilson. Accordingly, a preliminary map was prepared and placed in the hands of the observers taking part in this work. The present paper is the first of a series which will contain a preliminary catalogue of the lines affected on the original negatives, and should prove of service in connection with the map.¹ Since the intensities in the catalogue are mean values, derived from the discussion of several negatives, they naturally possess greater weight than

¹ It is perhaps desirable to emphasize the fact that in our previous publications on the spot spectrum we have made no attempt to give an exhaustive list of the lines affected in sun-spots for any region of the spectrum, but have treated merely some of the more prominent cases of strengthened and weakened lines. As an illustration of this it may be mentioned that in the region $H\beta$ to D a preliminary investigation indicates rather more than 225 lines which are weakened in spots. In a recent study of the same region Mr. Nagaraja of the Kodaikanal Observatory has given a list of 167 weakened lines (*Astrophysical Journal*, 26, 143, 1907). In this connection it may also be well to state that in our previous discussion of the weakened lines in the sun-spot spectrum on the temperature basis (*ibid.*, 24, 185, 1906), we have by no means maintained that all the weakened lines are spark lines. On the other hand, so far as our experience goes, it seems to be true without marked exception in the part of the spectrum extending from the red to $\lambda 4000$ that all spark lines are weakened. Mr. Nagaraja gives five lines in the region discussed by him which he considers exceptions to this rule. Of the first two of these lines, $\lambda 5169.07$ and $\lambda 5169.22$, it is the latter

estimates made directly from the map. It is expected that the detailed results from the individual plates will be published later, and it is also hoped that the preliminary map may ultimately be replaced by a more perfect one.

Although the instrument with which the negatives have been obtained, and the procedure followed in making the exposures have been described previously, it may be convenient for the purposes of reference to allude to them here. The spectrograph used was of the Littrow or auto-collimation type with a focal length of 18 feet (5.5 m) and having a 4-inch (10.2 cm) grating with 14,438 lines to the inch (570 lines to the mm). The photographs have all been made in the second order, which gives a linear scale of about 1 mm = 1.5 Å. The spectrograph has been used in conjunction with the Snow telescope, the concave mirror of which forms a solar image about 6.7 inches (17.0 cm) in diameter on the slit. During the exposure of the photographic plate to the spectrum of the spot the light from the photosphere is excluded from the slit, but at the conclusion of this exposure the ordinary solar spectrum is photographed on either side for purposes of comparison. This is readily done by means of an occulting bar which moves across the slit and has an opening of variable size which may be adjusted to the size of the spot under observation. The exposures are timed to give as nearly as possible the same intensity to the continuous spectrum of the spot and of the comparison spectrum. The ratio of the two exposures varies, of course, with the definition of the solar image, the transparency of the sky, and the size and blackness of the spot, as well as the wave-length of the region photographed. Under average conditions at λ 5500 the spot requires about six times as long as the comparison spectrum, while at λ 4000 this ratio increases to about ten or eleven.

The present paper contains a list of the lines affected in sun-spots for the region λ 4000 to λ 4500. It will be followed by other lists giving

which is the spark line, and it is decidedly weakened in spots; the former, on the other hand, is strengthened, and unless the dispersion of the instrument is sufficient to separate the two lines, it might well appear that the blend is not affected. The third line, λ 5188.87, seems to be distinctly weakened on our plates. The fourth and fifth lines, λ 5502.9 and λ 5621.7, either are not represented in the solar spectrum, or the lines are so faint (not above 000 on Rowland's scale) that conclusions can hardly be drawn as to their behavior.

the results obtained by one or both of us in other parts of the spectrum. Our series of photographs in the ultra-violet may not be completed for some time, and for this reason the present list begins at λ 4000.

The tables are of the same general character as those given by us in previous publications. The intensities are based upon Rowland's scale, and in the few instances in which his values for individual lines seem to need modification notes to this effect are added in the margin. For purposes of identification we have compared our list with the tables of the wave-lengths of arc lines by Hasselberg, and the "enhanced" line tables of Lockyer, the wave-lengths given in the marginal notes being from these sources. In general, only the more obvious identifications are included, and no attempt has been made to present alternative identifications unless they seem to be of special significance as regards the behavior of the lines in the spot spectrum. An extended discussion of this sort belongs rather to a detailed analysis of the results than to the catalogue proper, and we shall hope to enter into this subject farther in a concluding paper.

GEORGE E. HALE
WALTER S. ADAMS

The following is a list of the negatives employed in obtaining the results given in this paper. All of the plates were secured by Mr. Ellerman except L 128, which was taken by the writer.

TABLE I

Plate	Date	Greenwich Spot Number
L 76.....	1906, June 29	5898
L 77.....	June 30	5898
L 88.....	July 2	5898
L 82.....	July 2	5898
L 83.....	July 2	5898
L 84.....	July 2	5898
L 92.....	July 9	5898
L 94.....	July 30	5944
L 95.....	July 31	5944
L 101.....	Aug. 2	5944
L 128.....	1907, June 22	6205
L 134.....	July 19

In the case of plate L 134 the Greenwich spot number has not as yet been published.

TABLE II

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4000.61	<i>Fe</i>	2	2-3	3	
4001.32	<i>Mn</i> , —	3	2	4	
4003.08	—	2	1-2	6	
4003.91	<i>Ce-Fe-Ti</i>	3	3-4	3	Widened
4005.86	<i>V</i>	3	2-3	3	Spark line of <i>V</i>
4006.90	—	2	}	3	
06.98	—	1			
4009.02	—	2			
09.08	<i>Ti</i>	3	}	6	7
4009.29	—	1			
4009.81	<i>Ti</i>	1			
09.86	<i>Fe</i>	3	}	1-2	3
4010.33	<i>Ce-Fe</i>	1			
4010.74	—	3			
			2-3	3	Rowland's intensity too high: 2 better
4011.56	<i>Fe</i>	3	3-4	3	
4012.54	<i>Ti, Ce</i>	4	}	3-4	6
12.63	<i>Cr</i>	0			
4013.80	<i>Ti-Fe</i>	3			
4015.53	—	0	0-1	3	Hasselberg gives <i>Ti</i> 4015.56
4015.76	—	3	2	3	Narrow. Spark line of <i>Ni</i>
4017.93	<i>Ti</i>	0	0-1	3	
4018.23	<i>Mn</i>	3	}	9	4
18.27	<i>Mn</i>	4			
4019.20	<i>Ni-Ce</i>	1			
4019.45	<i>Co</i>	0	0-1	7	Widened Rowland's intensity too high: 00 better
4020.34	—	1	}	2	3
20.42	—	2			
4020.55	<i>Sc</i>	1			
20.64	<i>Fe</i>	1	}	3	8
4021.06	<i>Nd-Co</i>	3			
4022.02	<i>Ti-Fe-V</i>	5 d?		6	3
4022.37	<i>Fe</i>	1	1-2	4	
4023.53	<i>V, Co</i>	3	2-3	8	Spark line of <i>Co</i>
4023.83	<i>Sc</i>	2	3	7	
4024.73	<i>Ti</i>	3	4	3	
4025.16	<i>Cr</i>	0	}	4	7
25.29	<i>Ti-Ce</i>	3			
4026.32	<i>Cr</i>	0		1	8
4026.58	<i>Mn</i>	2 N	}	4	3
26.69	<i>Ti</i>	1			
4027.19	<i>Co</i>	1			
27.25	<i>Cr</i>	0	}	3	8
4027.82	—	1			
4028.50	<i>Ti-Ce</i>	4		0-1	7
4030.34	<i>Fe</i>	2	2-3	3	Spark line of <i>Ti</i>
4030.65	<i>Nd-Fe-Ti</i>	5	5-6	3	
4030.88	<i>Mn</i>	10 d?	11	4	
30.95					
4033.22	<i>Mn</i>	8 d?	10	3	Widened
33.34	<i>Fe?</i>	1			

LINES AFFECTED IN SUN-SPOTS

5

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4034.64	<i>Mn</i>	6 d	8	3	Widened, hazy
4036.52	—	0	0-1	8	
4036.92	<i>V</i> , —	1	0-1	7	
4037.27	—	2	2	8	Very hazy. Rowland's intensity
4038.94	—	2	2-3	3	[too high: 1 better]
4040.09	<i>Fe</i>	1	1-2	3	
4040.24	<i>Fe?</i>	2	1-2	3	
4040.79	<i>Fe</i>	3	4	4	Hazy. Rowland's intensity too
4041.43	<i>Fe</i>	3	}	5	Widened [high: 2 better]
41.52	<i>Mn</i>	5			
4044.06	<i>Fe</i>	3			
44.14	—	2	4	6	
4045.54	<i>Co</i>	5	5-6	3	Difficult: in shade of following line
4045.98	<i>Fe</i>	30	32	6	Probably slightly strengthened
4047.82	<i>Y</i>	0 N	}	7	
47.96	—	0 N			
4048.82	<i>Zr</i>	1	}	6	Widened
48.91	<i>Mn-Cr</i>	5			
4050.83	<i>Fe</i>	2	1-2	3	
4051.49	<i>Cr-V</i>	0 Nd?	0-1	3	
4052.60	<i>Mn, Fe</i>	2	}	3	Rowland's intensity too high: 4 better for total
52.65	—	3			
4053.98	<i>Cr-Fe-Ti</i>	3	2-3	7	
4054.59	<i>Zn</i>	0	}	3	Strengthened to red
54.71	<i>Sc</i>	00 N			
4054.96	<i>Fe</i>	2	}	6	
55.02	<i>Fe</i>	3			
4055.79	<i>Mn</i>	6	7	6	
4056.50	<i>Fe</i>	1	}	3	
56.60	—	0			
4057.37	<i>Co</i>	1 N	}	4	Not fully separated from follow- ing line
57.50	<i>Fe</i>	3			
4057.67	—	7	5	4	
4059.08	<i>Mn</i>	3	4	6	
4059.54	<i>Mn</i>	1 Nd?	}	3	Widened to red
59.65	—	0			
4059.87	<i>Fe</i>	2	1-2	7	
4060.42	<i>Ti</i>	1	2	8	
4060.64	—	0	00	3	Nearly obliterated
4060.92	—	0	0-1	3	
4061.78	<i>Mn</i>	2 Nd	2-3	6	Fringe on violet side
4062.10	—	2	1-2	3	
4062.60	<i>Fe</i>	5	5-6	5	Widened
4064.36	<i>Ti</i>	1	2	5	
4065.24	<i>Mn-Ti</i>	2 d?	3	7	
4066.52	<i>Co</i>	2	3	7	
4067.14	<i>Cr-Fe</i>	5	5-6	3	
4067.43	<i>Fe</i>	3	4-5	6	
4068.14	<i>Fe-Mn</i>	6	7	6	Very hazy, widened
4068.69	<i>Co</i>	0	0-1	3	
4070.43	<i>Mn</i>	3	4-5	7	Much widened

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observa- tions	Remarks
4073.92	<i>Ce, Fe</i>	4	5	4	
4075.26	— <i>Nd</i>	2 N	1-2	6	Rowland's intensity too high: 1 better
4076.10	<i>Fe</i>	3	2-3	7	
4077.88	<i>Sr</i>	8	8	6	Winged
4078.52	<i>Zr-Fe</i>	4	}	8	7
78.63	<i>Ti</i>	3			
4079.34	<i>Fe</i>	2	}	6	4
79.39	<i>Mn</i>	3			
4079.57	<i>Mn</i>	3	3-4	3	
4080.00	<i>Fe</i>	3	4	7	
4080.37	<i>Fe, Nd, Cr</i>	3	3-4	3	
4081.38	<i>Zr, Ce</i>	0	}	2	4
81.42	—	1			
4082.26	<i>Fe</i>	2	2-3	3	
4082.59	<i>Sc-Fe-Ti</i>	3	4	8	
4083.10	<i>V-Mn</i>	4	5	7	Widened
4083.72	<i>Fe</i>	2	}	7	4
83.78	<i>Mn, Y</i>	4			
4084.65	<i>Fe</i>	5	5	7	Perhaps winged
4085.47	<i>Fe</i>	4	5-6	7	Widened
4086.47	<i>Co</i> —	3 d?	4	7	Much widened
4086.86	<i>La</i>	1	1-2	3	
4089.37	<i>Fe</i>	3	4	6	
4090.73	<i>V</i>	1	2	8	
4091.11	<i>Ce</i> —	3	3-4	4	
4091.71	<i>Fe</i>	3	3-4	6	
4092.82	<i>V, Ca</i>	3 d?	4-5	8	
4095.09	<i>Ca?</i>	4	5	8	
4095.42	<i>Mn</i>	0	}	0	6
95.51	—	0			
4095.63	<i>V</i>	0	1	6	
4096.37	—	1	1-2	6	
4097.24	<i>Fe</i>	3	3	7	Very broad and hazy
4097.61	—	000	0	3	
4097.81	—	0	0-1	6	
4098.12	—	0	0-1	3	Seen as fringe on following line
4098.34	<i>Fe</i>	5	4-5	6	
4098.69	—	4	}	7	7
98.75	—, <i>Co?</i>	2			
4099.21	—	0	}	1-2	6
99.33	<i>Ti</i>	00			
4099.94	<i>V</i>	2	4	8	
4100.32	<i>Fe</i>	2	1-2	6	
4100.50	—	0	1	3	
4100.90	<i>Fe</i>	4	4-5	5	
4102.00	<i>H, In</i>	40 N	20	7	<i>H</i> δ is both narrowed and weakened
4102.32	<i>V</i>	0	1	7	
4103.10	<i>Si, Mn</i>	5	6	4	
4104.91	<i>Co, V</i>	00	0	7	
4105.32	<i>V</i>	2	4	8	Broad
4105.98	—	000	00	3	

LINES AFFECTED IN SUN-SPOTS

7

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observa- tions	Remarks
4106.42	<i>Fe</i>	2	3-4	7	
4106.58	<i>Fe</i>	2	1-2	6	
4106.8			0	3	Perhaps a blend of two faint solar lines
4107.65	<i>Ce-Fe</i>	5	6	4	Widened, hazy
4108.29	—	1	1-2	4	
4108.69	—	2	3	7	
4109.22	<i>Fe</i>	3	3-4	5	Narrow
4109.90	<i>V</i>	2	7	7	Much widened
09.95	<i>Fe</i>	3			
4111.15	—	1	00	3	Nearly obliterated
4111.51	<i>Ce?</i>	1	1-2	4	
4111.94	<i>V</i>	4	6	8	Very broad
4112.48	<i>Fe</i>	2	3	7	Much widened
4112.87	<i>Ti</i>	1	2	8	
4113.07	—	1	3	8	Narrow
13.12	<i>Fe</i>	3			
4113.68	—	000	Nd?	1	Broad patch
4114.27	—	00	d	0-1	3
4114.61	<i>Fe</i>	4	5	6	Widened
4115.33	<i>V</i>	3	4-5	8	
4116.63	<i>V</i>	1	3-4	8	
16.71	<i>V, Fe?</i>	0			
4116.97	<i>Nd?</i>	00	0	3	Seen as fringe on 4116.86
4117.11	—	0	0-1	3	
4117.59	—	000	0-1	3	Broad patch
4118.01	—	2	3	7	Widened
4118.31	<i>V</i>	0	0-1	7	
4118.71	<i>Fe</i>	5	6	5	
4118.93	<i>Co</i>	4	7	5	
19.05	<i>Fe</i>	2			
4120.78	—	0	1	3	Broad patch. Hasselberg gives <i>V</i>
4121.48	<i>Cr-Co</i>	6 d?	7	5	[4120.69]
4121.96	<i>Fe, Cr</i>	3	3-4	5	
4122.82	—	1	1-2	3	
4123.38	<i>La</i>	1	0	5	
4123.54	<i>Cr</i>	0	3-4	8	
23.66	<i>Ce, V-Mn</i>	1			
23.71	<i>Ti</i>	000			
4123.91	<i>Fe</i>	5	4	4	Rowland's intensity too high: 4 better
4124.64	—	0	0-1	3	
4125.53	—	000	0	3	
4125.78	<i>Fe</i>	3	3	5	Narrow
25.85	—	1			
4126.20	—	000	5	5	
26.34	<i>V-Fe</i>	4			
4126.67	<i>Cr</i>	2	3	7	Rowland's intensity too high: 1 better
4127.01	—	1	2	7	
27.07	<i>Cr</i>	00			
4128.25	<i>Ce-V, —</i>	6 d	8	6	

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observa- tions	Remarks
4128.46	—	00	0	3	
4128.89	—	2	0	7	Nearly obliterated; fringe on red side probably due to 4129.13
4129.34	Ce —	3	3-4	6	
4129.62	—	2	1-2	7	
4130.11	—	0	}	3	7
30.20	Fe	2			
4130.60	—	0			
30.80	Ba	2	}	3	6
4131.27	Ce, Mn	1			
4131.51	Cr	0	1	7	Hasselberg gives V 4131.32
4132.10	V	2	}	14	6
32.24	Fe-Co	10			
4132.69	—	3			
4133.06	Fe	4	4-5	5	
4133.76	Fe	2	0	7	Rowland's intensity too high: 1 better. Fringe to violet
4134.49	Fe?	3	}	7-8	6
34.59	Fe?	3			
4135.84	—	00	}	1-2	7
35.92	Zr	0			
4136.68	Fe	4	5	7	
4137.16	Fe	6	7	4	Spark line of Mn falls here
4137.43	Ti, Mn	0Nd?	}	3-4	7
37.57	—	2			
4138.13	—	0	0-1	3	Broad
4138.52	—	0 N	6	8	
4139.52	—	00	}	1	4
39.61	—	000			
4140.09	Fe	6	6-7	3	Broad patch. Hasselberg gives V 4139.39
4140.56	—, Fe?	3	3-4	7	Much widened, perhaps winged
4140.91	—	0	0-1	3	
4142.02	Fe	4	4-5	3	Widened
4143.57	Fe	4	}	5-6	5
43.66	—, Mo	2			
4144.04	Fe	15	13	6	Narrowed in spot
4146.22	Fe	3	3	6	Fringe on red side
4146.84	—	0 N	1	7	Broad
4147.14	—	2	1	7	
4147.50	—	2	1-2	3	Rowland's intensity too high: 1
4147.84	Fe	4	6-7	7	[better]
4148.55	—	00	0	3	
4149.53	Fe	4	5	6	Widened
4149.92	—	2	3	7	
4150.41	—	4	4-5	7	Rowland's intensity too high: 3
4150.61	Co	1	0	7	[better]
4151.13	Ce-Zr, Ti	1	1-2	6	
4152.24	—	1	}	4-5	5
52.34	Fe	3			
4152.69	C?	00			
52.76	Zr	00	0-1	3	Hasselberg gives V 4152.81
4152.93	Cr, La	0	00-0	3	

LINES AFFECTED IN SUN-SPOTS

9

TALBE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observa- tions	Remarks
4153.22	Cr	00	0-1	7	
4153.78	Co	0	0-1	3	
4153.97	Cr	1	6	6	Widened
54.07	Fe	4			
4154.67	Fe	4	4-5	7	
4154.98	Fe	4	4-5	5	
4155.21	—	00	0	2	
4155.68	—	00	1	3	Broad patch
55.80	—	00			
4156.07	—	1	0-1	3	
4156.39	Zr	1	2	4	
56.47	—	3			
4157.95	Fe	5	5-6	3	
4158.54	C?	0	1	7	
58.59	C?	00			
4159.35	—	5	4	7	
4159.80	Ti	0	1	4	
4160.53	—	2	3	7	Widened. Hasselberg gives V 4160.57
4161.37	Zr—	2	1-2	3	
4161.68	—	4	3-4	7	Widened. Spark line of Ti falls here
4161.96	Sr	1	00	7	Nearly obliterated. Spark line of Sr
4162.28	—	00 N	0	3	
4162.62	C, —	1 N	0-1	3	
4162.82	Ce, C	1 N	0-1	3	
4163.07	—	00	1	6	
63.14	—	000			
4163.64	—	0 d	0-1	3	
4163.82	Cr-Ti, —	4	3-4	4	Spark line of Ti
4164.80	—	0	2	7	Hasselberg gives Ti 4164.80
64.94	—	0			
4165.28	—	0	1	7	
4165.55	C, Fe	3 d	2-3	3	Narrow
4165.76	—, Ce	1	0-1	7	
4166.16	Ba	0	1-2	6	
66.26	—	00			
4166.36	—	00	2	6	Hasselberg gives Ti 4166.45
66.46	—	0			
4167.44	—	8	6	6	
4168.02	Ce-Fe	2	4-5	6	
68.13	Ni, C	2			
4168.63	—	00 N	3	7	Strengthening due to 4168.63
68.78	—	2			
4169.11	—	2	2-3	3	
4169.93	—	2	2-3	3	
4171.07	Fe	4	4-5	3	
4171.85	C, Fe?	2	2-3	6	
4172.07	Ti, Fe	2	1-2	6	Spark line of Ti
4172.21	Al	1	4-5	7	
72.30	Fe-Ce	2			

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4172.80	—	2	6	5	Weakened to violet, probably strengthened to red
72.92	Fe	4			
4173.14	—	1	0-1	6	
4173.62	—	3	4-5	7	Spark line of Fe Spark line of Ti
73.71	—	3			
4174.10	Fe	3	4	6	Weak to red. Spark line of Ti at 4174.20. Hasselberg gives V 4174.18
74.24	—	0			
4174.97	Cr	0	5-6	7	
75.08	Fe	4			
4175.29	—	1 N	0	7	
4175.81	Fe	5	5-6	3	
4178.22	—	2	1	7	
4179.02	—	3	2	7	Spark line of Fe
4179.54	V, —	3 d?	3-4	7	Widened
4180.56	—	1	1-2	6	
4181.35	—	0	0-1	3	
4181.92	Fe	5	5-6	4	
4182.14	—	2	1-2	7	Narrow
4182.92	—	2	1-2	4	Narrow
4183.17	—	1	0-1	5	
4183.48	Zr	1 N	2	7	Weak to red. Spark line of V at 4183.60
83.62	—	2 N			
4184.16	—	4	3	7	Rowland's intensity too high: 3 better
4184.47	—	2	1-2	7	Narrow. Spark line of Ti at 4184.40
4185.06	Fe, Cr	4	5-6	7	
4186.28	Ti	1	2	7	
4186.78	Ce-Zr	2 N	1-2	6	
4187.20	Fe	6	7	6	
4187.94	Fe	5	9	6	
88.02	—	3			
4188.89	—	4	3-4	5	
4189.14	C, —	1	2-3	4	
89.26	—	1			
4189.98	V	0 Nd?	1	7	Rowland's intensity too high: 00 better
4190.29	Cr	0 N	1-2	6	
90.40	C	0			
4190.87	C, Co	1 Nd?	2-3	8	
4191.60	Fe	6	7-8	7	Winged
4191.84	Fe	3	3-4	6	
4192.56	C	00 N	00-0	3	
4192.73	—	2 N	1	7	
4194.89	C, —	1	3	6	Very broad
95.01	Cr	1			
4195.49	Fe	5	5-6	6	
4195.68	—	1	3-4	7	
95.78	Fe-C	2			
4197.26	C	2	3	7	Widened to red
97.39	Cr	0			

LINES AFFECTED IN SUN-SPOTS

II

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks	
4197.81	—	00	1	6	Hasselberg gives <i>V</i> 4197.77	
97.90	—	00				
4198.22	<i>Fe</i>	2	2-3	4	Very hazy	
4198.40	—	4	7	4		
98.49	<i>Fe</i>	4				
4198.80	<i>Fe</i>	3	3-4	6		
4199.27	<i>Zr-Fe</i>	5	6	4		
4200.04	—	1 N	4	7		
00.15	<i>Fe</i>	2				
00.26	<i>Cr</i>	00				
4200.95	<i>Ti</i>	1	2	7	Winged	
4201.09	<i>Fe</i>	3	3-4	4		
4202.20	<i>Fe</i>	8	10	6		
4203.62	<i>Ti</i>	00 N	3-4	7		
03.73	<i>Cr</i>	2				
4204.88	—	1	2	5	Widened	
04.92	—	2				
4205.19	—	1	2	7		
05.24	—	1				
4205.70	—	2	2-3	5	Rowland's intensity too low: 5 better for total	
4206.74	—	1	5	6		
06.86	<i>Fe</i>	3				
4207.29	<i>Fe</i>	3	3-4	7	Widened	
4208.77	<i>Fe</i>	3	3-4	7		
4209.98	<i>V</i>	1	2	7		
4210.49	<i>Fe</i>	4	8-9	6		
10.56	—	3				
4211.13	—	3 N	2-3	3	Hasselberg gives <i>Ti</i> 4211.85	
4211.51	<i>C-Cr</i>	0 N	0-1	4		
4211.90	<i>Mn, C</i>	0	1	6		
4212.05	<i>Zr-</i>	2	1	7		
4213.81	<i>Fe</i>	3	3-4	7	Narrow	
4215.58	<i>Fe</i>	2	8	3	Spark line of <i>Sr</i>	
15.70	<i>Sr</i>	5 d?				
4216.35	<i>Fe</i>	3 d?	4-5	7	Widened	
4216.76	—	1 N	0-1	3		
4217.72	<i>La, Fe-Cr</i>	5 d?	5-6	3		
4218.56	— <i>Zr</i>	1 Nd	1-2	6		
4220.51	<i>Fe</i>	3	4	6	Hasselberg gives <i>V</i> 4224.30	
4221.63	—	1 N	1	4		
21.74	<i>Cr</i>	0				
4222.38	<i>Fe</i>	5	6	6		
4223.64	—	1	1-2	3		
23.74	—	1				
4224.34	<i>Fe</i>	4	5	3		
4224.67	<i>Cr-Fe</i>	3	4	7		
24.79	<i>Ti</i>	00				
4225.02	—	2 N	1-2	7	Spark line of <i>Cr</i>	
4225.62	<i>Fe</i>	3	3-4	5	Very difficult line. Widened and winged	
4226.90	<i>Ca</i>	20 d?	25	8		
4228.10	—	1 N	0-1	3		

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4229.68	<i>Fe</i>	2	2-3	3	Widened to violet
4229.93	<i>Fe</i>	3	4	4	Difficult
4232.76	<i>V</i>	00	3-4	9	
32.89	<i>Fe</i>	2			
4233.33	<i>Mn</i>	4	3	8	Strong spark line of <i>Fe</i> falls here
4133.77	<i>Fe</i>	6	7	7	
4234.17	<i>Co, V</i>	0 N	0-1	8	Rowland's intensity too high: 00 better
4234.71	<i>Zr</i>	0 N	1	8	Hasselberg gives <i>V</i> 4234.70
4235.30	<i>Mn</i>	2	6	4	
35.45	<i>Mn</i>	3			
4238.19	<i>Fe</i>	3	3-4	8	Widened
4239.52	—	2	2-3	8	
4239.89	<i>Fe, Mn</i>	3	9	5	
40.01	<i>Fe</i>	3			
40.12	—	1			
4240.54	<i>Fe</i>	2	4	8	Hasselberg gives <i>V</i> 4240.53
40.62	—	1			
4240.87	<i>Cr</i>	1	1-2	3	
4241.28	<i>Fe-Zr</i>	2	3	8	
4241.68	—	00 N	1	8	Broad patch
41.87	—	00 N			
4242.32	—	0	1	4	
4242.54	—	2	3	8	Spark line of <i>Cr</i> at 4242.54
42.62	—	2			
4243.98	—	2	1-2	3	Narrow
4245.42	<i>Fe</i>	4	8	7	Probably winged
45.52	—	2			
4247.00	<i>Sc</i>	5	6	5	
4247.46	—	1	6	4	Hasselberg gives <i>V</i> 4247.46
47.59	<i>Fe</i>	4			
4247.73	—	0	00	8	
4248.48	<i>Ti</i>	00	2	8	Widened to violet
48.58	—	1			
4249.10	—	2 N	1-2	8	
4250.29	<i>Fe</i>	8	9	5	
4252.39	—	00	1-2	9	Broad
52.47	<i>Co</i>	0			
4252.78	—	0 N	1	5	Weak to violet. Spark line of <i>Cr</i> at 4252.80
52.92	—	1 N			
4253.16	—	1	0-1	8	Spark line of <i>Mn</i>
4253.36	—	1	1-2	3	
4254.50	<i>Cr</i>	8	10	7	Widened: probably winged
4255.66	<i>Fe, Cr</i>	1	2-3	5	
55.79	—	1 N			
4256.29	<i>Ti</i>	0	2-3	4	Very broad
56.37	—	1			
4257.82	<i>Mn</i>	2	2-3	6	
4258.32	—	1 N	0-1	3	
4258.48	<i>Fe</i>	2	4	9	
4259.46	—	1 Nd?	2	3	Hasselberg gives <i>V</i> 4259.46
4260.64	<i>Fe</i>	10	9	4	Apparently narrowed in spot

LINES AFFECTED IN SUN-SPOTS

13

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4261.68	— <i>Cr</i>	2	3	7	Widened to red
61.75	<i>Ti</i>	00			
4262.09	—	1		8	
62.14	—	1	0-1	8	Spark line of <i>Cr</i> at 4262.15
4263.29	<i>Ti, Cr</i>	2	3	8	
4264.37	<i>Fe</i>	3	4	4	
4264.90	<i>Fe</i>	2	1-2	3	
4265.83	<i>Ti</i>	0	0-1	8	
4266.08	<i>Mn</i>	2	2-3	8	
4266.78	—	0	0-1	3	Rowland's intensity too high: 00 better
4267.12	<i>Fe</i>	3	3-4	7	
4268.78	—	0	3-4	7	Hasselberg gives <i>V</i> 4268.78
68.92	<i>Fe</i>	2			
4269.45	—	0	000	3	Nearly obliterated. Perhaps spark line of <i>Cr</i>
4269.90	—	2	3	8	
70.02	—	2 N			
4271.93	<i>Fe</i>	15	15	7	Very hazy. Probably narrowed in spot
4272.70	<i>Ti, —</i>	1	2	8	
4274.75	<i>Ti</i>	2	12	8	Much widened to violet
74.96	<i>Cr</i>	7 d?			
4277.15	<i>V, —</i>	1 N	1-2	6	
4277.69	—	2 d?	3	8	Much widened
4278.39	<i>Fe-Ti</i>	3	3-4	6	Narrow
4279.01	<i>Ti, —</i>	1 N	1-2	7	
4279.87	—	2 Nd?	1	3	
4280.56	<i>Cr</i>	1	2	8	Broad
4280.94	—	1	0-1	3	
4281.26	<i>Mn</i>	2	2-3	6	Narrow
4281.53	<i>Ti</i>	0	1-2	8	
4282.13	—	2 N	1-2	3	
4282.56	<i>Fe</i>	5	6	3	
4282.86	<i>Ti</i>	0	0-1	8	
4283.17	<i>Ca</i>	4	5-6	9	
4283.90	—	000	0	3	
4284.22	<i>Mn, V</i>	0	0-1	3	Seen as fringe on following line
4284.38	—	2 Nd?	1	9	Spark line of <i>Cr</i>
4284.99	—	1	0-1	3	Rowland's intensity too high: 0 better
4285.16	<i>Ti, —</i>	2	2-3	8	
4285.52	—	1	3-4	4	
85.60	<i>Fe</i>	3			
85.69	—	1			
4286.17	<i>Ti, —</i>	2	3-4	8	Narrow
4287.57	<i>Ti</i>	1	2	8	
4288.31	<i>Ti, Fe</i>	1	2	4	
4288.89	—	(00 N)	1	3	Evident error in Rowland's intensity. Map shows strong line here. Spot intensity is on basis of 2 in sun

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4289.12	—	1	4-5	8	
89.24	Ti	2			
4289.52	Ca	4	5	8	
4289.88	Cr	5	8	8	Ti line probably weakened.
90.08	Ti	1			
4290.38	Ti	2	1-2	6	Narrow. Spark line of Ti
4291.11	Ti	3	3-4	8	
4291.28	Ti	2	2-3	3	
91.38	—	1			
4291.63	Fe	2	3-4	8	Widened
4292.14	Cr, V	0	0-1	8	Difficult. Seen as fringe on following line
4292.21	—	1	2	5	Spark line of Mn at 4292.35
92.29	—	2			
4292.45	—	2	2-3	7	
4293.19	—	2	4	8	
93.27	—	3			
4294.20	Ti	2	9	8	Spark line of Ti
94.30	Fe	5			
4295.19	—	3 d?	4-5	8	
95.38	—	3 Nd?			
4295.91	Cr, Ti	2	3-4	8	Narrow
4296.74	—	3	3	5	Spark line of Fe at 4296.72
96.84	Zr?	1			
4297.37	—	2	3	5	
97.45	—	2			
4297.68	—	1 N	0-1	5	
4297.91	Cr, V	0	0-1	8	
4298.14	Ti	1	4	8	
98.20	Fe	2			
4298.36	—	1	0-1	3	
4298.83	Ti	2	3	8	
4298.97	—	2	1	3	
4299.15	Ca	3	4	9	
4299.41	Ti, Fe	4	5	3	
4299.80	Fe, Ti	2	3	9	
4299.99	—	1 N	0-1	3	
4300.21	Ti	3	2-3	9	Spark line of Ti. Rowland's intensity too low: 4 better
4300.48	—	1 N	0-1	3	
4300.73	Ti	2	3	8	
4300.99	—	1	0-1	7	
4301.16	Ti	2	8	8	Weak on red edge; Ti line strengthened
01.26	—	4			
01.33	—	1	00-0	3	
4301.90	—	0 Nd?			
4302.08	Ti	2	1-2	4	Spark line of Ti
4302.69	Ca	4	6	9	Probably winged
4303.34	—	2	1	8	Spark line of Fe
4303.58	—	1 N	0-1	3	
4303.99	—	2	4	8	
04.10	—	4			

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4304.42	—	1	0-1	3	
4304.55	—	1	0-1	3	
4304.73	Fe, —	2	1-2	6	
4305.27	—	1	0-1	7	
4305.48	—	1	3-4	5	Spark line of Sr
05.61	Fe, Sr, Ti, Cr	3			
4306.08	Ti	4	5-6	8	
4306.86	—	2	3	8	
07.02	—	2			
4307.91	Ca	3	10	8	Violet component probably strengthened, red weakened. Spark line of Ti at 4308.10
08.08	Fe	6			
4309.06	—	1	2-3	7	
09.20	Fe	2			
4309.54	Fe	3	3-4	7	
4309.79	—	1	1	5	
09.88	—	1			
4309.99	—	0	1-2	7	Hasselberg gives V 4309.95
10.07	—	0			
4310.27	—	2	1	7	
4310.54	—	2	2-3	4	
10.63	—	1			
4310.86	—	2 N	2-3	6	
4311.06	—	1	1-2	6	
11.15	—	1			
4311.61	—	2	2-3	5	Spark line of Mo at 4311.71
11.67	—	2			
4312.25	—	2	2	4	
12.31	—	1			
4313.03	Ti	3	2-3	7	Spark line of Ti
4213.80	—	2 Nd?	1-2	3	
4314.25	Sc	3	3-4	7	
4314.96	Ti	1	2-3	8	
4315.14	Ti	3	8	6	Spark line of Ti
15.26	Fe	4			
4316.96	Ti?	1	0-1	8	Spark line of Ti
4318.82	Ca, Mn?	4	6	8	Winged. Hasselberg gives Ti 4318.83
4320.66	—	0	1-2	7	
20.76	—	00			
4321.12	—	2	1-2	7	Possibly spark line of Ti
4321.81	Ti	0	1	8	
4323.39	—	2 Nd?	1	5	
4324.01	—	3	2	5	
4324.57	—	2 N	1-2	4	
4325.15	Sc	4	6	7	Widened to red
25.31	Ti, Cr	1			
4325.94	Fe	8	8	6	Apparently narrowed in spot
4326.52	Ti	0	1	7	Narrow
4327.27	Fe	3	2-3	3	
4328.08	Fe	2	2-3	6	
4328.77	—	0 N	00-0	8	Much widened: very hazy

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4329.45	—	o N	o	3	
29.56	—	o N			
4330.19	V	o N			
4330.40	—	1	o	7	
4330.57	—	o	oo-o	3	Spark line of <i>Ti</i> at 4330.50
30.61	—	o			
4330.87	<i>Ti, Ni</i>	2	1-2	8	Spark line of <i>Ti</i>
4331.81	<i>Ni</i>	2	2	7	Very narrow line in spot. Measures show no change
4332.99	V	o	2	9	
33.08	—	o			
4335.10	<i>La</i>	o	1	7	Broad. Hasselberg gives <i>Ti</i> 4334.98
4337.22	<i>Fe</i>	5	7	8	Winged
4337.72	<i>Cr</i>	3	4-5	8	
4338.08	<i>Ti</i>	4	3	9	Spark line of <i>Ti</i>
4338.43	<i>Fe</i>	1	2	9	
4339.62	<i>Cr</i>	4	6	8	
4339.88	<i>Cr</i>	3	4	8	
4340.30	<i>Cr</i>	o	o-1	7	
4340.63	<i>H</i>	20 N	8	8	<i>Hγ</i> is both weakened and narrowed
4341.17	V	o	2	9	
4341.53	<i>Ti?</i>	2	1	8	Spark line of <i>Ti</i>
4342.35	—	o	1	3	Broad patch
42.48	—	oo			
4343.37	<i>Cr</i>	2	4-5	7	
43.43	<i>Fe</i>	2			
4343.86	<i>Fe</i>	2	2-3	3	
4344.13	—	1 N	o	3	Rowland's intensity too high: o better. Spark line of <i>Mn</i>
4344.45	<i>Ti</i> , —	2	1-2	7	Spark line of <i>Ti</i>
4344.67	<i>Cr</i>	4	6	8	
4345.05	—	o	oo	3	
4345.25	—	oo	o-1	3	Broad patch
45.40	—	oooo			
4346.28	—	oo	oo-o	3	Hasselberg gives <i>Ti</i> 4346.26
4346.45	—	1	o-1	9	
4346.99	<i>Cr</i>	1	1-2	9	Rowland's intensity too high: o better
4347.40	<i>Fe</i>	1	2	9	
4348.50	—	1 N	o-1	7	
4349.11	<i>Fe</i>	2	2-3	3	
4351.00	<i>Ti</i>	1	o-1	9	Spark line of <i>Ti</i>
4351.22	<i>Cr</i>	3	5	8	
4351.93	<i>Cr</i>	5	11	7	Strengthening very doubtful. Spark line of <i>Fe</i> at 4351.93
52.08	<i>Mg</i>	5Nd?			
4352.91	<i>Fe</i>	4	7	9	Widened to red
53.04	V	o			
4355.26	<i>Ca?</i>	2	3	9	Perhaps winged
4356.06	—	o	2	9	Strengthening due mainly to violet component. Hasselberg gives V 4356.10
56.16	<i>Ni</i>	o			

LINES AFFECTED IN SUN-SPOTS

17

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4356.53	—	o	oo	4	
4356.77	—	o	o-1	6	Widened to red
4359.65	Ni	o			
59.78	Cr	3	5	4	Spark line of Zr
59.91	Zr	o			
4360.45	—	1	o-1	4	
4360.64	Ti	1	1-2	7	
4362.91	—	o N	oo	3	
4363.27	Cr	1 N	1-2	4	
4363.46	—	o N	oo-o	4	Rowland's intensity too low: 1 better
4363.63	—	o			
63.77	—	o	1-2	8	Very broad. Hasselberg gives V 4363.69
4365.17	—	ooo	oo	3	
4366.06	Fe	2	2-3	3	
4367.22	—	ooo	o	3	Hasselberg gives V 4367.24
4367.75	Fe	5	6	8	Weak at red edge. Spark line of Ti
67.84	Ti	2			
4368.07	Fe	2	2-3	7	Narrow
4368.22	—	oo	o	3	Hasselberg gives V 4368.25
4369.05	Ti	oo Nd?	o	3	
4369.57	—	1	o	6	
4371.14	Zr	1			
71.22	—	1	1-2	7	Spark line of Zr
4371.44	Cr	2	3-4	7	
4372.50	—	o d?	o-1	7	Very broad. Hasselberg gives Ti 4372.54
4372.90	—	o		6	
73.01	—	o	o		
4373.42	Cr	1	2-3	7	Hasselberg gives V 4373.40
4373.73	Fe	2	1-2	5	Narrow
4374.98	Zr	o			
75.10	V, Mn	2	3-4	4	
4375.73	—	o	o	5	
75.82	—	o			
4376.11	Fe	6	8	6	Probably winged
4377.39	—	2 N			
77.53	—	o d?	1-2	6	
4378.42	—	2 Nd?	1-2	5	
4379.40	V	4	7	6	Very broad
4380.32	Co	2 Nd?	1	6	
4380.88	—	2 Nd?	1	5	Broad
4381.27	Cr	o	o-1	5	Hazy, broad
4382.85	Mn	o			
82.93	—, Fe	2	1-2	6	
4384.48	—	1	o	4	
4384.87	V	3	4-5	6	Much widened
4385.14	Cr	2	3	6	
4385.55	—	2	o-1	5	Spark line of Fe
4387.01	Ti?	1	o	7	Spark line of Ti
4387.22	—	1 N	o	6	Possibly spark line of Pb
4388.06	Fe, Co	2	2-3	4	Widened

TABLE II—*Continued*

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4388.89	—	o	o	3	Weak on red edge. Spark line of <i>Ti</i>
89.03	—	o N			
4389.41	<i>Fe</i> , —	2	3	6	
4390.15	<i>V</i>	2	4	7	
4391.12	<i>Fe</i>	2	2-3	3	
91.19	<i>Ti</i>	1			
4391.82	<i>Co</i>	o	3	7	
91.92	<i>Cr</i>	1			
92.03	<i>Co</i>	o			
4392.24	<i>V?</i>	1 N	1-2	7	
4393.44	—	o	1	7	
4393.69	—	1 Nd?	o	5	
4393.97	<i>V?</i>	o	1-2	6	Narrow
94.09	<i>Ti</i>	o			
4394.22	<i>Ti?</i>	2	1-2	5	
4394.94	—	oo	o-1	3	Hasselberg gives <i>V</i> 4394.98
95.02	<i>Zr</i>	oo			
4395.20	<i>Ti</i>	3	2-3	7	Narrow. Spark line of <i>Ti</i>
4395.41	<i>V</i> , <i>Zr</i>	2	3	7	
4396.01	<i>Ti</i>	1	o-1	6	Spark line of <i>Ti</i>
4397.12	—	1 N	o-1	4	
4399.94	<i>Ti</i> , <i>Cr</i>	3	2-3	6	Spark line of <i>Ti</i>
4400.56	<i>Sc</i>	3	3-4	6	
4400.74	<i>V</i>	1	3	7	Possibly spark line of <i>Pb</i>
4401.18	—	1 N	o-1	4	
4403.35	—	1	o-1	6	Apparently narrowed in spot
4404.43	<i>Ti</i>	1 N	1-2	4	
4404.93	<i>Fe</i>	10	9	6	Very broad
4406.81	<i>V</i> , —	2	4	7	
4407.81	<i>V</i>	2	8	7	Widened to red
07.87	<i>Fe</i>	4			
4408.36	<i>V</i>	2	3-4	7	Widened. Spark line of <i>Ti</i> falls here.
4408.58	<i>Fe</i>	3	7	7	
08.68	<i>V</i>	2	oo	5	Hazy
4409.41	—	o			
4409.68	—	1	o-1	4	Apparently narrowed in spot
4410.68	<i>Ni</i>	2	1-2	3	
4411.24	<i>Cr</i> —	1	1-2	3	Narrow
4412.09	—	1	o	6	
4412.30	<i>V</i>	oo	2	6	Broad
12.42	<i>Cr</i>	o			
4413.76	—	1	o	6	Spark line of <i>Ti</i>
4415.29	<i>Fe</i>	8	7	4	
4415.72	—	3	2-3	6	Greatly widened. Rowland's in- tensity too low: 2 better
4416.64	<i>V</i>	o	2-3	7	
4416.98	—	2	1	6	Spark line of <i>Ti</i>
4417.45	<i>Ti</i>	o	1-2	7	
17.58	<i>Co</i>	oo	2-3	6	Spark line of <i>Ti</i>
4417.88	<i>Ti</i> , —	3			
4418.50	<i>Ti</i> , —	1	o-1	5	

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observa- tions	Remarks
4419.94 20.10	<i>Mn</i> <i>V</i>	00 N 00 N } 0	1-2 00	7 6	Widened to red
4420.45	—	0	00	6	
4421.73	<i>V</i>	0	2-3	7	Very broad
4421.93	<i>Ti</i>	00	0	3	Perhaps spark line of <i>Ti</i>
4422.10	—	1	00-0	6	
4422.98	<i>Ti</i>	0	1	7	
4423.30	<i>Fe</i>	1			Broad. Hasselberg gives <i>V</i>
23.43	<i>Cr</i>	0 N } 0	2	7	4423.32 and <i>V</i> 4423.41
4424.01	<i>Fe?</i> —	2	1-2	3	Narrow
4424.46	<i>Cr</i>	0 } 00	1-2	6	Hasselberg gives <i>Ti</i> 4424.58
24.53	—	00			
4425.61	<i>Ca</i>	4	5-6	7	Winged
4426.20	<i>Ti</i>	0 Nd?	2	7	
4427.27	<i>Ti</i>	2	3	7	
4427.48	<i>Fe</i>	5	7	6	Winged
4428.71	<i>V-Cr</i>	1 d?	2	7	
4429.96	<i>V</i>	00	1	7	
4430.36	<i>Fe</i>	1	0	7	
4430.52	—	00	00-0	3	
4430.78	<i>Fe</i>	3	3-4	3	
4431.30	—	0 N	00	5	
4431.52	—	0	0-1	6	Hasselberg gives <i>Ti</i> 4431.46
4432.74	<i>Fe</i>	1	1-2	4	
4434.17	<i>Ti</i>	0 Nd?	1-2	7	
4435.13	<i>Ca</i>	5	7	7	Winged
4435.32	<i>Fe</i>	2	3	5	
4435.85	<i>Ca</i>	4	6	6	Winged
4436.31	<i>V</i>	0	1-2	7	
4436.75	—	00	0	6	Hasselberg gives <i>Ti</i> 4436.75
4437.11	<i>Fe-Ni</i>	2 d?	1-2	4	Narrow
4437.73	—	0	00	6	
4438.01	<i>V</i>	0	2	7	
4438.51	<i>Fe</i>	1	1-2	4	Very much widened
4440.05	<i>Fe</i>	1	2	4	Narrow
4440.52	<i>Ti</i>	00	1	6	
4440.99	—	1	0-1	6	
4441.15	<i>Fe</i>	0 } 0	0	6	
41.26	—	00			
4441.43	<i>Ti</i>	00	0	6	
4441.88	<i>V</i> , —	3 Nd?	5	7	Very broad
4443.00	<i>Fe</i>	1	1-2	6	Narrow
4443.98	<i>Ti</i>	5	4	7	Spark line of <i>Ti</i>
4444.38	—	0	2-3	7	Rowland's identification <i>V-Ti</i> for 4444.57 evidently belongs to this line. Hasselberg gives both <i>V</i> and <i>Ti</i> here
4444.73	<i>Fe, Ti</i>	2	1-2	6	
4445.64	<i>Fe</i>	1	2	7	
4447.30	<i>Mn, Fe</i>	2	2-3	4	
4447.89	<i>Fe</i>	6	8	6	Winged
4449.31	<i>Ti</i>	2	3	7	

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observa- tions	Remarks
4450.65	<i>Ti?</i>	2	1-2	6	Narrow. Spark line of <i>Ti</i>
4451.09	<i>Ti</i>	1	2	6	
4452.17	<i>V</i>	0 N	2	7	
4453.17	<i>Mn</i>	1	1-2	3	
4453.49	<i>Ti</i>	2	3	7	
4453.88	<i>Ti</i>	1	2	6	
4454.55	<i>Fe</i>	3	3-4	4	
4454.95	<i>Ca, Zr</i>	5	7	6	Winged
4455.48	<i>Mn, Ti</i>	2	3	6	
4455.98	<i>Mn</i>	2	}	7	Winged
56.06	<i>Ca</i>	3			
4456.79	<i>Ca</i>	2	3-4	7	Perhaps winged
4457.60	<i>Ti, V, Zr</i>	2	}	6	Strengthened to violet
57.71	<i>Mn</i>	2			
4458.24	<i>Fe?</i>	2	1-2	6	
4459.52	<i>Cr</i>	1	1-2	4	Widened
4459.92	<i>V</i>	1	2-3	7	
4460.39	<i>V</i>	0	}	7	Rowland's intensity too low: 3 better for total
60.46	<i>Mn</i>	1			
60.52	—	0			
4461.82	<i>Fe</i>	4	6	6	Much widened
4462.16	<i>Fe-Mn</i>	3 Nd?	3-4	7	Widened
4463.57	<i>Ti-Ni</i>	0	}	6	Widened to red
63.70	—	00			
63.84	<i>Ti</i>	0000			
4464.62	<i>Ti?</i>	2	1-2	6	Narrow. Spark line of <i>Ti</i>
4464.84	<i>Mn</i>	2	}	3	
64.94	<i>Fe</i>	1			
4465.98	<i>Ti</i>	1	2	7	Rowland's intensity too high: 0 better
4466.73	<i>Fe</i>	5	6	6	Widened, hazy
4468.66	<i>Ti, —</i>	5	4-5	7	Spark line of <i>Ti</i>
4469.32	<i>Ti</i>	1	0-1	6	
4469.54	<i>Fe</i>	4	4	4	Narrow, probably winged
4469.87	<i>V</i>	00	0	7	
4470.30	<i>Mn</i>	1	1-2	6	
4471.41	<i>Ti</i>	0	2	7	
4471.72	—	00 N	}	7	Very broad
71.85	—	0			
71.97	—	00			
4472.88	<i>Fe</i>	1	}	4	Widened to red. Rowland's in- tensity too low: 2 better for total
72.97	<i>Mn</i>	0			
4473.10	<i>Ni?</i>	0	00	6	
4474.21	—	00	0	4	Hasselberg gives <i>V</i> 4474.21
4475.03	<i>Ti</i>	0	2-3	7	
4475.47	<i>Cr</i>	00	0	6	
4476.18	<i>Fe</i>	4	}	4	Perhaps winged
76.25	<i>Ag</i>	3			
4477.23	—	00	0	3	
4478.19	—	0	0-1	3	
4479.78	<i>Fe</i>	1	}	6	Widened to red
79.88	<i>Ti</i>	00			

TABLE II—Continued

λ	Element	Intensity Rowland	Intensity Spot	Number of Observations	Remarks
4480.31	<i>Fe</i>	1	2	6	
4480.75	<i>Ti, Ni</i>	0 N	0-1	6	
4480.99	—	0	00-0	3	
4481.30	—	0	000	6	Nearly obliterated. Rowland's intensity too low: 1 better
4481.44	<i>Ti</i>	1	2	6	
81.52	—	0			
4482.34	<i>Fe</i> ,—	5	11	6	Much widened
82.44	<i>Fe</i>	3			
4482.90	<i>Ti-Fe</i>	1	2-3	6	Very hazy
83.04	<i>Cr</i>	00			
4484.39	<i>Fe</i>	4	4-5	3	
4488.22	<i>Fe-Cr</i>	0	2	6	Widened to violet
88.30	—	1			
4488.49	—	1	0	7	Spark line of <i>Ti</i>
4488.93	<i>V</i>	0000	2	7	Widened to violet
89.08	<i>Fe</i>	1			
4489.26	<i>Ti</i>	0	3	6	Widened to violet. Spark line of <i>Fe</i> at 4489.35
89.35	—	2			
4489.91	<i>Fe</i>	4	6	6	
4490.25	<i>Mn-Fe</i>	3 N	3-4	6	
4491.57	—	2	0-1	6	Spark line of <i>Fe</i>
4491.82	<i>Cr-Mn</i>	0	0-1	6	Rowland's intensity too high: 00 better
4492.48	<i>Cr, Fe</i>	0	0-1	6	Much widened
4493.70	—	1	0-1	6	Fringe on red side
4494.22	—	1	1-2	6	Much widened
4494.74	<i>Fe</i>	6	7-8	6	
4495.18	<i>Ti</i>	00	0	6	
4496.32	<i>Ti</i>	1	2-3	7	
4497.02	<i>Cr</i>	3	4-5	6	Hasselberg gives <i>V</i> 4497.03
4497.84	<i>Ti</i>	0 N	1-2	7	
4498.90	<i>Cr</i>	0	0-1	6	Rowland's intensity too high: 00 better
4499.07	<i>Mn</i>	1	1-2	6	Rowland's intensity too low: 2 better
4499.31	—	1	0-1	6	

MOUNT WILSON, CAL.
November 1907