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The corresponding data for ionized lanthanum are contained in the next table.

LINES OF IONIZED LANTHANUM

Lines identified in Cygni by Adams and Joy are marked with an asterisk in the f rst column. Lines which have been classified (Gousmid, Naturwiss, 41, 851, 1924) are marked by a dagger in the first column. Lines that appear to be primarily due to ionized lanthanum are marked by a double dagger in the last column.

LINES OF IONIZED EUROPIUM

Wave Length	Arc	Spark	Sun Rowland		Chromosphere Mitchell		Cygni Lockyer
4129.90	100	100	4130.112	0	4129.99	Eu	5
4205.20	100	50	4205.421	000	4205.22	V-Eu	8

The first of these lines, which are the two strongest in the europium spectrum, is probably an ionized europium line, and is apparently present in the spectrum of Cygni.

The lines identified by Lockyer are traceable on Harvard spectra of Cygni and Canis Majoris, which resembles it very closely. It is proposed to derive fresh wave lengths from the Harvard plates.

Cecilia H. Payne

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Wave Length	Arc	Spark	Sun Rowland		Chromosphere Mitchell		Cygni Lockyer
5205.90	10	10	5205.897	Y 0	5205.06	Y-Cr-Ti 6d	
5402.98	4	8	5402.982	Y 0	5402.96	M 1	
5497.60	5	8	5497.624	0000	5497.61	Y,Cd,Fe 8	
5663.15	10	15	5663.155	Ti,Fe,Y 1	5663.15	Y-Ti-Fe 3N	

The above list contains all lines of yttrium that are not of intensity stronger than 5 weakened in the spark. Lines for which series relations have been published by Meggers (J.Wash.Acad.Sci.,14,419,1924) are marked by a dagger. The last five lines in the table are outside the spectral range discussed by Lockyer,but the region is accessible on Harvard plates,and will be included in the general line identifications for Cygni. The line at 5087.61 is found in the spectrum of Cygni by Adams and Joy (Loc.Cit.) There can be little doubt that the lines of ionized yttrium are present in the spectrum of Cygni,in stronger every case in which they are not obscured by strong lines of other elements.

LINES OF IONIZED ZIRCONIUM

The arc and spark behavior of the lines included in the table,and their relative intensities in the sun and the chromosphere,both seem to indicate that the ionized atom is involved. The lines that appear to be primarily due to ionized zirconium are marked,in the last column,by a double dagger.

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General wave length tables

Enhanced lines between 3800 and 6000

Lithium	✓ = unnecessary	Nitrogen neutral	p. 80
Sodium	✓ "	Ruthenium I	102
Magnesium	✓	Oxygen +	88
Aluminum	✓		
Potassium	✓		
Calcium	✓		
Scandium			
Titanium	✓		
Vanadium	p. 10, p. 66		
Chromium			
Manganese	p. 24		
Iron	✓		
Cobalt	p. 14		
Nickel	p. 16 . Wallers' list 108		
Copper	p. 30		
Zinc	p 72		
Rubidium	✓		
Strontium	✓		
Yttrium	p. 120		
Zirconium	p. 6.		
Molybdenum	p. 20		
Silver			
Cadmium	p. 18		
Tin			
Caesium	✓		
Barium	✓		
Lanthanum	p. 2.		
Europium	p 28		
Terbium			
Hafnium	p 32		

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Lanthanum +

Wave length I.A.	Rows.	Intensity arc	Intensity spark	Series	
3849.02		6	10		
3871.65		8	15		
3886.34		8	10	$1^3D-1^3D'$	La +
3916.04		8	10		
3921.54				$1^3D-1^3D'$	La +
3929.21		8	12		
3949.10		12	20		
3988.52	88.67	10	15	$1^3D-1^3D'$	La +
4031.70	31.85	8	15	$1^3D-1^3D'$	La +
4042.92	43.07	8	15		
4050.09	50.24	6	10		
4067.35	67.52	6	8		
4077.34	77.49	10	12		
4086.70	86.85	10	15		
4099.53	99.68	5	10		Given by Lockyer as La +
4123.24	23.39	10	15		
4151.95	52.11	10	10		
4192.34	92.50	7	8		Given by Lockyer as La +
4196.55	96.71	10	10		
4230.96	31.12	4	6		
4238.40	38.56	10	10		
4250.00	50.16	6	6		
4263.59	63.75	8	8		
4269.50	69.66	10	10		
4286.97	87.13	10	12		
4333.52	33.68	12	12		
4334.97	35.13	6	8		
4354.39	54.56	8	10		
4383.45	83.62	8	8		
4427.54	27.74	7	8		
4429.90	30.07	10	10		

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Rowland Wave length	Int.	Remark	Spot	Chromosphere wavelength	Int.	Lockyer χ Cyg	Int	Int CHP.	SCHa CHP	Blend
3849.14	3d?	La-C	out	3849.07 La-C	1	out of range				
3871.527	2d?	C (Cyanogen band head)	of	3871.94 Fe,La	1	line here				
(3886.434	15	Fe)	range	3886.46 Fe-La	15	3886.9 Fe	3-4			
3916.207	0 Nd?	Zr-La	0	3916.10 Zr-La	3	3916.1 Cr(?)	4			
3921.695	4	La								
3929.363	2	Fe-La-Mn	0	3929.30 La-Fe	1	In wing of K				Ca+
3949.199	1	La	0	3949.21 La	4	3948.9	2-3	✓		
3988 .617	0	La (cpd line)	0	3988.61 La	6	3988.6 –	3	✓	3	
3988 .659	0									
3988 .705	0									
4031.865	2	Fe-La	+?	4031.83 La	2	in Mn group				Mn
4043.054	0	La	0	4043.01 La	4	4043.0 ?La	1-2	✓	3	
4050.294	000	La	0	4050.46 Zr	2	4050.6 –	2	✓	4	
4067.558	000	La	0	4067.57 La	0	4067.3	8	✓	7	
4077.498	1Nd?	La, Y	0			4077.9 (Sr+)	8		(10)	Sr+
4086.861	1	La	0	4086.79 La	4	4086.9 ?La	4-5	✓	5	
4099.727	000	La	0	(4099.95 V	2	4100.6 (Fe)	2	✓	2	
4123.384	1	La	0	412345 La-V	5	4123.8 –	4	✓	4	
4152.108	2	Fe, La	0	4152.23 La, Ce-Fe	6N	4152.3 Fe	3		4	
4192.258	00	La?	0	~~4196.75 La~~	~~2~~	~~4196.4~~	~~4~~	✓	3	
4192.356	00	La?								
4196.699	2	La	0	4196.75 La	2	4196.4	4	✓	7	
(4231.12	4N	Ni)	0	4231.18 La-Ni	2				-	
4238.555	1Nc?	La	0	4238.55 La	2	4239.0	5	✓	5	
(4250.205	000	–)	0	Under Fe?		4250.3 Fe	4		(8)	Fe
4263.760	0d?	La	0?	?		4264.2 4263.7	1	✓	..	
4269.625	0	La	0	4269.68 La	1	4269.5	2-3	✓	2	
4287.159	2	La	0	4287.05 La-	1				line here (2)	
4333.925	1N	La	0	4333.88 La	5	4334.0 ?La	4-5	✓	7	
4335.102	0	La	0	4335.43 –	0					
4354.597	00	—	0	4353.80 Ce-La	0	4355.2 Ca	3-4		(7)	Ca
(4383.72	15	Fe)	–	4383.15 —	0	4383.7 Fe	4-5		(11)	Fe
4427.760	000	La	–	4427.91 La-Ce	1	4427.4 Fe+Mgt	3-4		(5)	Fe+Mgt
27.875	0000	La	–							
4430.070	00N	La	+	4430.15 La	4	4430.6 Fe			(5)	Fe
30.221	00N	La								

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Lanthanum (continued)

Wave length I.A.	Rowland	Intensity arc	spark	Series	
4522.37	22.54	10	12		
4525.30	25.47	7	8		
4526.12	26.29	8	8	^{1}P-^{3}D'	La +
4613.39				^{1}P-^{3}D'	La +
4619.87	20.05	6	6		
4655.50	55.68	7	10		
4663.77	63.95	5	8		
4668.91	69.09	5	8		
4671.82	72.00	4	5		
4724.39				^{1}P-^{3}D'	La +
4743.08	43.26	10	10		
4921.78	21.96	7	8		

4728.595 ✓
4636.6 ✓
4713.1 ✓
4740.42 ✓
4809.18 ✓
5302.1 ✓
5493.65 ✓

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γ Cyg

Rowland Wave length	Int.	Remark	Spec.	Chromosphere	Int.	Lockyer	Int	Int CHP	Int. CHP	Blend
4522.418	0000	La	0	4522.50 La	1	4522.8 Fe,Ti	4		(6)	
4525.412	000	–	0	4526.26 La	1					
4526.269	0	Cr	0+ ↓			~~4525.5~~ (Ba+)	2		(5)	
4613.544	3	~~Cr, La~~								
4620.072	0000	–	0	4619.98 V-La	0	4619.2	4	✓	5	
4655.634	000 Nd	–	0			4655.3	2	✓	4	
~~4664.017~~	~~000N~~	–	0?	4663.99 La,Cr	2	4663.6	2-3	✓	6 w	
4663.999	1	~~Cr~~								
4664.017	000N	~~La~~ –	0	4664.62..	2d		-	✓	line here	
4672.00	000	–	0	4672.51..	3N			✓	line here?	
4742.592	0	–								
4743.289	000	–	0	4743.23 La	1		) –	line here?	line here?	
4921.147	0	La	0	4921.10 La	1					

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8

Zirconium +

Wave length I.A.	Rowland	Intensity arc.	spark.	Series.	
3958.22	58.37	8	15		Zr + Lockyer
3991.13	91.28	8	12		
3998.96	99.11	8	12		
4045.73	45.88	4	8		
4048.66	48.81	6	10		
4050.31	50.46	4	6		
4085.69	85.84	4	4		
4149.20	49.35	10	15		
4150.98	51.14	5	6		
4156.23	56.39	6	10		
4161.21	61.37	8	10		
4179.79	79.95	–	6		
4208.96	09.12	6	12		
4211.85	12.01	5	5		
4227.73	27.89	7	10		
4239.30	39.46	6	10		
4268.00	68.16	4	4		
4282.19	82.35	8	8		Adams + Joy
4347.89	48.05	7	7		
4359.74	59.91	9	10		Zr + Lockyer
4366.44	66.61	4	4		
4370.95	71.12	8	8		Zr + Lockyer
4379.77	79.94	10	12		Zr + Lockyer
4443.17	43.16	10	5		Zr + Lockyer
4494.57	94.74	–	10		Zr + Lockyer
4496.96	97.13	5	10		Zr + Lockyer
4507.11	07.28	5	8		
4535.75	35.92	5	8		Class S Merrill
4542.22	42.39	5	5		" " "
4553.97	54.15	–	6		
4575.52	75.70	5	6		Class S Merrill

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Rowland Wave length	Int.	Rem.	Spot	Chromosphere	Int.	Lockyer	Int.	Int Cliff	δ CM	Blend
										(γ Cyg)
3958.355	5	Ti, Zr		3958.37 Zr, Ti	8	3958.4	4-5	✓		Ti
3991.333	3	Cr, Zr		3991.30 Zr-Cr	5	3991.1	3-4	✓		Cr?
3999.117	-.1	Zr, Fe		3998.88 Ti Zr	4	—				—
4045.975	30	Fe		4045.98 Fe	15	4046.0	8			Fe
4048.818	.1	Zr		4048.88 Zr-Mn -Fe	5d	4048.9	4	✓		Mn
4050.482	0	Zr		4050.46 Zr	2	4050.6	(2)	✓		—
4085.881	00	—				4085.3 d?	4-5	✓		?/H
4149.360	2	Zr		4149.37 Zr	8	4149.4 d?	5-6	✓		Fe
4151.129	1	Zr, Ti		4151.18 Zr-Ti-Ca	3			✓		
4156.391	1	Zr		4156.30 ~~4161.23~~ Zr-Nd	8	4156.7	(6)	✓		Un
4161.369	2	Zr-		4161.23 Zr-	1	4161.7	6-7	-		Sr+
4179.978	0	Zr		4179.58 V-Pr	3	4179.0	5	✓		Fe+
4209.144	1	Zr		4209.11 Zr	4	4209.2	(4-5)	✓ V+ also		—
4212.048	2	Zr-		4212.04 Zr-C ?	3	4212.0	(3)	✓		—
4227.918	0	Zr		4227.88 Zr-V-Ca -Nd	2	4226.9	8	✓		Ca
4239.525	2	—				4239.0	5	✓		Fe
4268.138	0	Zr		4268.20 Zr-	1			✓		
4282.370	00	—		4282.10 —	2	4282.8	(5)	✓		Fe
4348.003	2	Fe		4348.06 Zr-Sa- Fe	2	4348.0	(1)	✓		Fe? —
4359.907	0	Zr		4359.81 Cr, Zr	5	4359.8	3	-		Cr
4366.660	1	Zr-		4366.72 Zr-	2d					
4371.144	1	Zr		4371.17 Zr	3	4371.7	2-3	✓		Ti, Cr
4379.927	0	Zr		4379.92 Zr	2	4379.4	3	✓		V
4443.161	0	Zr		4443.19 Zr	3	4444.0	9	✓		Ti+
4494.738s	6	Fe		4494.71 Fe-Zr	3	4494.7	3-4	✓		Fe
4497.138	0	Zr		4497.11 Zr	3	4497.6	(3-4)	✓		—
4507.266	0000	—		4507.47 Zr	0	4507.0	(1)	✓		—
4535.909	0	Zr		4535.74 Ti	3	4536.6	2-3			Ti
4542.400	0N	Zr		4542.42 Zr	1	"				
4554.211s	8	Ba		4553.28 Ba-Zr	20	4554.2	5-6			Ba+
4575.726	00N	Zr		—						

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Zirconium, continued

Wave length I. A.	Rowland	Arc	Spark	
4602.57	02.75	4	4	
4626.41	26.59	–	6	
4633.99	34.17	6	8	Class S Merrill
4687.80	87.98	7	12	Class S, Merrill
4688.45	88.63	5	10	
4710.08	10.26	8	10	Class S, Merrill
4719.11	19.29	5	5	
4732.32	32.50	6	8	
4739.47	39.65	8	10	
4772.31	72.49	6	10	Class S, Merrill
4784.94	85.12	4	5	
4788.24	88.42	4	4	

6100.33 Adams + Joy

Zr + Kiess unpub. terms JOSA 13, 17, 1926

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γ Cygni

Rowland	Int.	Rem.	Spot	Chromosphere	Int.	Lockyer	Int	HP	δ Cyg	Blend
4602.717	0000	—		—		4603.2	2			Fe+
4626.532	00N	—				4626.2 4634.2	2 2-3			Cr?
4634.187	0000	—		4634.21 Cr-Zr	3	↓	↓			Cr?
4687.981	0	Zr		4687.94 Zr	0	4686.0	(1)	✓		—
4688.651	000	—		4688.72 Zr-Sa	1N	4689.2	(1)	✓		—
4710.252	000N	—		—		(4708.6)	5			Ti+
4719.407	00	—		4719.32 Zr	0	4719.6	3?	✓		—
4732.501	000	—		—		4731.3	4			Fe+
4739.635	00	—		4739.80 ..	0	4740.9	1?	✓		—
4772.511	000	—		—		4771.2	2			Fe+
4785.256	0000	—		—		47867	2-3			Y+
4788.403	0000	—		—		—				

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Vanadium

Exposures Hasselaki

Wave Length I. A.	Rowland	Arc	Spark					
3815.53	15.68	3	10					
47.34	47.49	4	10					
78		(1)	(10)	$a^3\bar{G}_3 - {}^3\bar{F}_4$	3878.736	(35)	V+ Meggers	–
99.14	99.29	–	5	$a^3\bar{G}_4 - {}^3\bar{F}_3$	3899.137	(20)	V+ "	–
3903.35	03.50	–	5	$^3P_2 - {}^5D_3$	3903.262	(25)	V+ "	VE
14.33	14.48	–	8	$a^3G_3 - {}^3F_2$	3914.329	(20)	V+ "	–
16.42	16.57	–	8	$^3P_1 - b^3D_2$	3916.416	(20)	V+ "	VE
73.65	73.80	–	10	$^3P_1 - a^3D_2$	3973.639	(15)	V+ "	–
97.15	97.30	–	8	$^3P_2 - a^3D_3$	3997.121	(15)	V+ "	VE
4005.73	05.88	–	20	$a^3G_5 - {}^3F_5$	4005.712	(60)	V+ "	V
23.35	23.50	–	20	$a^3G_4 - {}^3G_4$	4023.376	(50)	V+ "	VE
35.62	35.77	–	20	$a^3G_3 - {}^3G_3$	4035.622	(40)	V+ "	VE
65.09	65.24	–	6					
83				$b^3G_5 - {}^3F_4$	4083.428	(35)	V+ "	–
(4105.20	05.35	10	4	$^1D - {}^1D'$) not enhanced				
4268.63	68.79	8	10					
77								
79.96	79.12	–	5	$^3S_1 - {}^3P_1$	4278.92	(15)	V+ "	
4308.50	08.67	15	20	$^1D - {}^1F'$ not enhanced				
16.60	16.77	–	10	$^1D - {}^1F$ " "				
62.38	62.55	8	10					
69.70	69.87	6	8					
96.08	96.25	5	6					
4528.49	28.66	5	5					
49.64	49.81	5	8					
60.72	60.90	8	10					
64.58	64.76	–	10					
72.78	71.96	4	10					
80.39	80.57	8	10	$^4F - {}^4G'$ not enhanced				
4619.71	19.89	8	10	$^4F - {}^4G'$ not enhanced				

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Rowland	Int.	Rem.	Chromosphere	Int.
			-	
3847.477	00	V	-	
	(11)		3878.79 Fe V Co	15
3899.277	2		3899.23 V-Fe [2]	3
3903.553	000		3903.33 V-Cr [2]	4
(3914.477	2	Ti)	3914.60 V-Zr	4
3916.545	3		3916.67 V-Cr-Fe-Gd [3]	2
3973.796	1	Fe	3973.74 Zr	5
3997.258	1	Cr?	-	
4005.856	3		4005.88 V	6
4023.533	3	Co-	4023.56 V-Co	4
4035.752	2	Co	4035.70 V-Co	3
4065.239	2d?	Mn-Ti	4065.46 V-Ti [2]	2
(4105.318	2	V)		
4268.606	000N			
(4408.683	2	V)		
(4416.636	0	V)		
4462.525	00	V	4462.68 V-Ni (2)	1
4469.873	00	V	4469.76 Co,V	0
(4496.318	1	Ti)		
4528.647	0N		4528.76 Fe-V ( )	5
(4549.642	2	Fe)		
4560.892	00		4560.87 V	0
4564.750	00		4564.79 V	1
4571.976	00		-	
(4580.590	1	V)		
(4619.963	00			

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Vanadium (continued) (V)

Wave Length I.A.	Rowland				
4796.94	97.12	8	10		
4831.66	31.84	5	5	$^4F - ^4D'$	not enhanced
4904.40	04.58	5	8		
5128.53	28.70	8	10		
38.43	38.60	8	10		
93.02	93.19	4	5		
95.83	95.00	4	8		
5234					
41					
53 53					
5401.95	02.16	8	10		
5488.01	88.22	4	8		
5507.75	07.97	—	8		
92.45	92.67	4	5	$^4F - ^6D'$ $^4D - ^4D'$	not enhanced " "
5707.02	07.24	8	10		
5897					

3727.348	$^3F - ^3F'$	V+	Meggers Kiess + Walters
3760.230	$^3F - ^3F'$	V+	
3718.163	$^3F - ^3F'$	V+	
3750.873	$^3F - ^3F'$	V+	
3778.359	$^3F - ^3F'$	V+	
3743.63	$^3F - ^3F'$	V+	
3770.976	$^3F - ^3F'$	V+	

For further classified lines of V+ see p. 66

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Rowland	Int	Rem	Spot	Chromosphere	Int
4797.090	ooo	V			
4831.831	oo	V			
4904.597	3				
5128.660	ooo				
5138.690	oooo				
5193.139s	2	Ti			
3727.488	1			3727.53 V-	2
3760.364	1			.	
3718.291	ON			.	
3751.015	2			.	
(3778.463)	3	(Fe)		3778.44 Fe-V-Ni	1
(3743.726)	1	(Cr)		.	
3771.116	2			.	

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14 Cobalt (Co)

Wave Length

I.B.	Rowland	arc	spark	Series	
3816					
42.05	42.20	8	10		
45.45	45.60	10	15		
61.15	61.30	6	10		
73.07	73.22	10	12	$1^4F'-1^4D$	not enhanced
74.94	74.09	9	10	$1^4F'-1^4D$	" "
81.86	82.01	6	6		
94.09	94.24	10	15		
3935.97	36.12	9	10		
69.13	69.28	4	6		
91.68	91.83	–	8		
4092.40	92.55	8	10		
4118.78	18.93	8	10		
45					
60.70	60.86	8	–		
90.71	90.87	5	–		
4414					
4530.95	31.12	10	10		
33.99	34.16	6	4		
49.62	49.79	6	5		
65.62	65.80	8	8		
69					
81.58	81.76	10	10		
Lines picked out in sunspot spectrum					
4779.99	80.17	8	5		
4792.87	93.05	8	8		
4813.48	13.66	9	10		
4869.88	68.06	10	10		
Lockyer					
4244					

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Rowland	Int.	Rem.	Spot
3842.191	3	Co	
3845.606	8d?	Co-C	
3861.299	4Nd?	C-Co-C	
3873.224	2	Co	
3874.091	4	Co-C	
3882.011	2	C-Co	
3894.241	5d	Co	
3936.121	2	Co	
3969.287	0N	Cr, Co	
3991.830	2	Co-Cr	
4092.547	3	Co, Mn	
4118.934	4	Co +	
4160.942	0	-	
4190.874	1Nd?	C, Co	
4531.123	2	Fe?, Co	
4534.139	6	Ti-Co	
4549.808	6d?	Ti-Co	
4565.842	2	Co-Fe	
4581.693	4	Co, Fe	
4780.169	2	Co	-
4793.045	1	Co	-
4813.661	1	Co	-
4868.056	1	Co	-

-?

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1924phae.proj.10961

16 Nickel

Wave Length IA.	Rows.	Arc	Spr.	Series
4401.54	01.71	15	15	
59.03	59.20	10	8	
70.48	70.65	10	4	
4509				

List of weakened spr lines of Nickel

6378.23	78.44	6	-
6384.68	84.89	5	-
4976	-		
5010	-		
5080.53	80.71	7	-
80.11	81.29	8	-
82	-		
84.09	84.27	6	-
94			
5625.32	25.54	7	-
6120			
6204.63	04.84	5	-
6230		-	-
6361.031			
~~6359~~		-	
6370.40	70.61	4	-
6414.63	14.84	6	-
6592			

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Rowland	Int.	Rem.	Sp'd	Chromosphere	Int
4401.709	2	Ni	-?		
4459.199	2	Ni			
4470.648	2	Ni-Zr			
6378.468	2	Ni	-		
6884.886	1	Ni	-		
4967.508	1	Ni	-	-	
5010.199	0	Ni	-	5011.12 Ni	1
5080.714	4	Ni	-	5080.76 Ni	1
5081.286	3	Ni	-	5081.26 Ni	1
5082.526	2	Ni	-	-	
5084.279	3	Ni	-	5084.30 Ni	2
5094.594	0	Ni	-	-	
5625.541	0	Ni	-	5625.61 Ni-	2d?
6119.970	0	Ni	-		
6204.825	1	Ni	-		
6230.312	0	Ni	-		
6361.031	0	Ni	-		
6370.574	00	Ni	-		
6414.813	0	Ni	-		
6592.770	00	Ni	-		

I.P. of Ni must be about 9 Volts.

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1924phys.proj.1096

18 Cadmium (Cd) See also Ruark & Chenault Stages in the excitation of the sp. of Cd. JOSA 10, 553, 1925

Wave Length A.	Rowland				
3940.2	40.4	-	8		
59.7	58.9	-	7		
76.6	76.8	-	6		
82					
85					
88					
92					
4034					
95.8	95.0	-	7		
97					
4114					
17					
19					
27.9	27.1	-	6		
45					
58					
4236					
41					
4415.68	15.85	4	-	Cd	not enhanced
4693					
5472.3	72.5	6	-	Cd	" "
76					
90.0	90.2	6	-	Cd	" "
53338.3	38.5	10	10		
79.9	79.2	10	10		
42916.9	17.1	-	6		

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K.T. Compton
Note on the production of atomic N and its arc spectrum
Phil Mag 50, 512, 1925

W C Mc Quarrie
A note on the sp of Si and Al
Phil Mag 50, 819, 1925

Glockler. Phil Mag 50, 997, 1925
I.P. of radon, theoretically.

He	24.5
Ne	21.5
A	15.4
Kr	13.3
Xe	11.5
Nt	(10.0 ± .9)

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20 Molybdenum (Mo)

	Wave Length I.A.	Rowland	Arc	Spark	
	3932				
	33				
	61				
	71				Given by Lockyer as Mo+
	72				" " " " "
	82				
	3908				
	25				" " " " "
	25				
	31				" " " " "
	41.51	41.66	–	8	" " " " "
*	61				" " " " "
	67				
	86.25	86.40	–	6	
	91				" " " " "
	4013				" " " " "
	4119				" " " " "
	4122				" " " " "
	25				" " " " "
	4139				" " " " "
	41				" " " " "
	47				
	61				" " " " "
	71				
*	4209				" " " " "
	27				
*	44.78	44.94	–	6	
*	50.70	50.86	–	8	" " " " "
*	79.01	79.17	–	8	
*	4311.06	11.22	–	4	" " " " "
*	11.66	11.82	–	4	" " " " "

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Molybdenum (continued)

Wave Length I.A.	Row	
4328		Given by Lockyer as Mo +
* 58		" " " " "
* 63		" " " " "
* 77		" " " " "
* 4412		" " " " "
* 33		" " " " "

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Manganese (Mn)

Wave length

I.A.	Rowl.	Arc	Spark	Atom	Series	
3809.59	09.74	5	4	Mn	1^6D-1^6F	not enhanced
23.88	24.03	4	4	Mn	1^6D-1^6F	" "
39.78	39.93	4	4			
41.72	41.87	4	5	Mn	1^6D-1^6F	" "
44	–	–	–			
83						
3926.47	26.62	4	4			
82						
86						
87						
4026						
35				Mn	$1^6D-1^6D'$	" "
55.55	55.70	10	6	Mn	$1^6D-1^6D'$	" "
59.92	59.07	5	4	Mn	$1^6D-1^6D'$	" "
63.55	63.70	7	4			
79.43	79.58	7	4	Mn	$1^6D-1^6D'$	" "
79.20	79.35	7	4	Mn	$1^6D-1^6D'$	" "
82.92	83.07	8	6	Mn	$1^6D-1^6D'$	" "
83.62 ~~83.35~~	83.77 ~~83.50~~	8	6	Mn	$1^6D-1^6D'$	" "
4110.92	11.07	6	–	Mn	?	" "
31.13	31.28	6	–	Mn	?	" "
90						
4235.31	35.47	6	4	Mn	$1^4D-1^4P'$	" "
.13	35.29	6	4	Mn	$1^4D-1^4P'$	" "
57.65	57.81	5	–	Mn	$1^4D-1^4P'$	" "
66.92	66.08	5	–	Mn	$1^4D-1^4P'$	" "
81.10	81.26	5	–	Mn	$1^4D-1^4P'$	" "
92						
4326						
4414.88	15.05	6	4	Mn	$1^4D-1^4D'$	" "
36.35	36.52	5	4	Mn	$1^4D-1^4D'$	" "

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Manganese (continued)

Wave Length I.A.	Row[2]	Arc	Spark	Atom	Series	
4451.58	51.75	6	5	Mn	$1^4D - 1^4D'$	not enhanced
64.68	64.85	6	4	Mn	$1^4D - 1^4D'$	" "
70.14	70.31	6	4	Mn	$1^4D - 1^4D'$	" "
4709.71	09.89	7	4	Mn	$1^4D - 1^4F'$	" "

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Europium (Eu)

Wave Length I.A.	Row.		
3819.80	19.94	50R	50
3907.28	07.42	30	30
30.66	30.80	50	50
72.16	72.30	50	50
88.36	88.50	21	12
4011.85	11.99	83	13
12.95	13.10	1	3
4129.90	30.05	100	100
4205.20	05.36	100	50
4435.74	35.90	50	30
4522.80	22.97	20	15
94.23	94.40	100R	10
4627.43	27.60	100R	8
62.10	62.27	50	5

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Rowland	Int.	Rem. Spot. Chromosphere		
3819.938	00	C?		
3907.433	000			
3930.804	0			
(3972.313)	2	Ni		
–				
(4011.865)	2	Fe		
4013.107 ~~4012.9~~	00			
4130.112	0		4129.88	Eu 5
4205.421	000		4205.22	V-Eu 8
(4435.851)	4	Ca		
(4522.974)	2	Ti		
4594.459	000N			
4627.547	0			
4662.278	000			

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30
Wave Length
I. A. Rowland

Copper.

(Lockyer)
4545
4556

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Hafnium (all strong lines)

Wave Length I.A.	Row.		
3800.39	00.53	4	4
17.04	17.18	2	3
80.78	80.92	3	3
89.31	89.45	3	4
92.45	92.59	2	3
95.62	95.76	2	1
99.92	00.06	4	5
3906.87	07.01	3	3
09.18	09.32	3	3d
17.42	17.56	4	4
18.06	18.20	6	6
23.90	24.04	5	5
26.40	26.54	3	3
27.57	27.71	2	4
31.33	31.47	3	4
31.78	31.92	2	2
35.67	35.81	3	3
38.40	38.54	1d	2
39.00	39.14	3	3
41.17	41.31	1	1
45.31	45.45	2	2
49.47	49.61	1	2
50.76	50.90	3	4
51.80	51.94	5	5
64.94	65.08	3	4
68.02	68.16	2	2
70.08	70.22	4	3 B.H.
79.34	79.48	3	4
84.02	84.16	3	4
96.77	96.91	2	3

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Rowland	Int	Rem.
-		
3817.198	00	C
3880.931	1	C
~~3889.486~~ 3889.498	0 1d?	Mn
3892.~~450~~ 590	00	
(3895.803)	(7)	(Fe)
3899.963	0N	
-		
-		
-		
3918.223	0N	
3924.065	000	
3926.597	2N	Mn
3927.748	0	
3931.483	0N	
-		
-		
3938.552	4	
3939.112	00	
3941.323	1	
(3945.473)	(3N) (Co)	(Co)
-		
3950.938	000	
3951.917	0N	Co
-		
3968.114	1	Fe
(3970.177)	(5)	(H)
3979.466	00	
(3984.113)	(4)	(Fe)
3996.935	0	

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Hafnium (all lines) continued

4003.76	03.90	2	2
07.34	07.49	2	3
08.44	08.59	2	3
11.48	11.63	2	2d
20.26	20.41	3	3
29.18	29.33	3	3
32.28	32.43	4	4
33.87	34.02	1	2d
44.38	44.53	3	3
47.97	48.12	3	4
49.44	49.59	3	3
50.62	50.77	3	3d
50.90	51.05	3	3
57.45	57.60	3	2
62.85	63.00	4.5	5
64.78	64.93	2	2
66.20	66.35	4	4
67.81	67.96	2	3
80.44	80.59	5	5
83.33	83.48	4	4
93.16	93.31	6	6
4104.24	04.39	2	3
13.53	13.68	4	4.5
27.75	27.90	4.5	5
36.36	36.52	2d	3d
45.75	45.91	3	4
58.87	59.03	3	4
62.34	62.50	4	4
74.32	74.48	4.5	5
77.47	77.63	3	4

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Rowland

4003.772	00N	
(4007.429)	(3)	(Fe)
4008.568	000	
4011.693	00	Mn
4020.424	2	
4029.319	000	
4032.418	00	
4034.052	00	
4044.531	00	
–		
4049.590	00	
–		
4051.095	00	
4057.668	7	
–		
4064.913	000	La
4066.375	1	
4068.015	00	
4080.588	00	
4083.515	000	
–		
–		
4113.679	000Nd?	
(4127.957)	(4)	(Fe)
4136.527	00	
4145.914	1N	
–		
4162.454	00N	
4174.479	00	
(4177.698)	(3)	(Fe)

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Hafnium (all lines) continued

Wave length I.A.	Row (red)*	Arc	Spark	Series
4206.53	06.69	4.5	5.5	
09.68	09.84	3	3	
28.00	28.16	3	3	
32.36	32.52	4.5	6	
45.82	45.98	3	4	
49.30	49.46	4.5	4.5	
52.00	52.16	4	4	B.H.
61.00	61.16	3	4	
62.70	62.86	3	3	
63.40	63.56	4	4	
69.66	69.82	4	4	
72.82	72.98	4.5	5	
96.40	96.56	3	3	
4303.59	03.75	3	3	
18.15	18.31	4	4	
20.65	20.81	4.5	5	
22.65	22.81	1	2	
30.30	30.46	4.5	4.5	
34.63	34.79	3	4.5	
35.13	35.29	2	3	
36.69	36.85	5	6	
49.77	49.93	3	3	
50.52	50.68	4	6	
52.59	52.75	3	3	
53.37	53.53	3	3d	
56.32	56.48	5	6	
65.37	65.53	3	3	
67.91	68.07	4	5	
79.18	79.34	2	2d	
85.46	85.62	1	2	

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Rowland	Int.	Rem.	Spl	Chromosphere	Int
4206.735	1	-	+	4206.99 Fe-Pr	2d
4209.962	0	-	+		
4228.103	1N	-	0	4228.34 Nd	0
4232.353 (544)	00N	-	+	4232.60 V Nd	0
4245.969	0000N	-	?		
4249.416	00	-	+	4249.68 -	1
4252.218	00Nd?	-	+		
4261.162	000N	-	+?		
4262.864	0	-	+		
4263.581	00N	-	+?		
4269.898	2	-	0	4269.83 V	1
4273.049	1d?	-	+	4272.93 Nd-V	1
4296.548	000N	-			
4303.754	1	-	?	4303.93 Nd-Sr	1
4318.369	00	-	+?		
4320.756	00	-		4322.58 La-V	1
4322.862	00N	-	+?		
4330.405	1	-	+	4330.23 V	2
4334.833	0	-	-		
4335.248	00N	-		4335.43 -	0 ~~1?~~
		-	-	4336.12 -	1
4349.967	00	-	?	4349.90 Ti-Ce	1
		-			
4352.718	0N	-		4352.97 Fe V	5d?
4353.596	00N	-		4353.80 Ca-La	0
4356.528	0	-		4356.88 -	1
		-		4365.49 -	0
4368.071	2	Fe	0	4368.11 Fe, V	0
(4379.396	4	V)	0		
4385.548	2		-	4385.60 Fe	5

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Hafnium

4408.85	09.01	3	3
4415.05	15.21	–	2
4416.14	16.30	2	2
4417.34	17.50	4.5	6
4417.85	18.01	3	4
22.24	22.40	2	2
22.70	22.86	4	5
30.56	30.72	1	1
32.94	33.10	1	2d
38.02	38.18	4	4
52.95	53.11	3	3
66.38	66.54	3	3
73.04	73.20	1	–
86.14	86.30	4.5	4.5
90.60	90.76	2	3
99.64	99.80	2	3
4518.30	18.47	3	3
20.59	20.76	2	3
24.66	24.83	–	3
33.15	33.32	5	5
35.32	35.49	2	3
40.88	41.05	4	4
41.28	41.45	1	3
41.73	41.90	1	1
43.00	43.17	2	2
44.00	44.17	4	4
46.96	47.13	2	2d
47.76	47.93	–	2
62.70	62.87	3	3d
65.93	66.10	5	5

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Rowland

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Hafnium (continued)

Wave Length I.A.	Obs.	Arc	Spark	Series
4570.62	70.19	2	3	
73.78	73.95	4	4	
86.24	86.41	-	3	
97.94	98.11	3	3	
98.86	99.03	6	6	
4605.76	05.93	3	4	
08.10	08.27	4	4	
13.71	13.88	3d	3	
19.46	19.63	2	2	
20.85	21.02	6	5	
22.70	22.87	4.5	5	
42.24	42.41	4	3	
48.34	48.51	-	2d	
50.61	50.78	2	3d	
52.08	52.25	2d	3d	
55.18	55.35	6	5	
59.21	59.38	-	2	
64.13	64.30	5.5	5.5	
69.24	69.41	2	2	
70.93	71.10	-	2	
99.02	99.20	4	4.5	
99.70	99.88	3	4	
4708.85	09.03	3	3	
21.74	21.92	3	3	
35.62	35.81	3	3d	
38.61	38.80	3	3	
57.60	57.79	3	3	
60.53	60.72	2	3	
65.80	65.99	2	3	
66.51	66.70	4	4.5	

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Rowland	Int.	Rem.	Spot	Chromosphere	Int.
4590.199	00N		+h		
4573.960	000	Ba?	+h		
4586.408	1	Cr	0		
4598.186	0000		not seen		
4599.109	000		+?h		
-					
4608.305	000		+h		
4613.892	00		+s		
4619.607	0000		not seen		
4620.986	000N		not seen		
4622.929	0	Cr	+		
4642.424	00		+s		
4648.497	000		+h		
4650.725	00		+		
-					
4655.419	00N				
4659.338	000Nd?				
4664.358	00N				
-					
4671.080	00				
4699.127	00		ø+		
4699.899	00N		0		
-			(+)		
4721.927	0000		0		
4735.843	000		+		
-			(+*)		
4757.771	2	Fe	+		
-			(+h)		
-			(+)		
-			not seen		

*3 lines not in Rowland

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1924phae.proj.1996

Hafnium

4773.73	73.92	4	4
74.90	75.09	3	3
77.16	77.35	1	2d
82.77	82.96	4	5
90.72	90.90	3	4.5
95.98	96.17	2	2
4800.51	00.69	6	6
07.14	07.32	2	3
09.24	09.42	2	2
11.14	11.32	2	3
13.86	14.04	1	2
17.20	17.38	3	4.5
18.86	19.04	4	4
34.18	34.36	4.5	3
37.24	37.42	5	5
43.98	44.16	3	3
48.48	48.66	2	3
50.62	50.80	3	3
58.43	58.61	3	4
59.24	59.42	4.3	5.5
60.58	60.76	1	1
61.52	61.70	2	1
63.29	63.47	4	5
65.44	65.62	2	3
72.95	73.13	3	3
77.59	77.77	4.5	5
78.14	78.32	3	3
89.78	89.96	2d	1d
96.36	96.54	3	3
4903.02	03.20	2d	3

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1924phae.proj.10961

Rowland

4773.900 0000

–

4777.370 0000

4782.998 000

4790.937 000

–

4800.728 0000

–

4809.455 000

–

4813.908 0000.N

–

–

4834.356 0000

4837.382 0000

–

4848.656 000

–

(4858.675) (0000)

(4859.485) (0000)

(4861.173) (0)

(4861) 30 H width 0.750 A

4863.431 0000

(4865.798) (1)

(4873.276) 0000

4877.772 0

(4878.313) (3) (Ca)

–

–

4903.278 0000

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Hafnium

4904.44	04.62	3	4
06.29	06.47	1d	1d
07.20	07.38	2d	1
10.05	10.23	2	2
15.24	15.42	4	3
20.88	21.06	2	2
33.88	34.06	var	1-4
34.34	34.52	4.5	4.5
45.32	45.50	4	3
47.34	47.52	2	1
65.30	65.47	2	2
69.26	69.43	2	1
75.20	75.37	6	5
76.92	77.09	2	2
84.66	84.83	2	2
92.26	92.43	3	2
99.59	99.76	5	4
5000.56	00.73	2	2
18.14	18.31	6	4.5
21.09	21.26	3	2
25.80	25.97	2	2
37.32	37.49	2	1d
40.79	40.96	6	6
45.28	45.45	1	1
47.43	47.60	5	4
51.31	51.48	2	1
58.09	58.26	3	2
71.18	71.35	2	1
74.71	74.88	3	3
75.90	76.07	2	2

B.H.

49

49

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1924phae.proj.1096

4915.414 000 Ti

4934.277 4 –

–

–

–

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Hafnium

5079.57	79.74	3	3d	B.H.?
90.86	91.03	2		
93.84	94.01	4	2	B.H.
5100.68	00.85	2		
01.64	01.81	2		
06.55	06.72	2		
28.50	28.67	4	2d	
53.15	53.32	3	1	
70.22	70.38	4.5	2	
81.92	82.08	6	3	
87.75	87.91	4	2	
94.56	94.72	2		
5208.85	09.01	3		
43.97	44.13	5.5	2	
44.60	44.77	3		
47.07	47.24	4	2	
54.38	54.55	2d		
58.75	58.92	2		
60.41	60.58	4	2	
64.92	65.09	4.5	3	
75.05	75.22	4	1	
86.09	86.26	3		
92.76	92.93	2d		
98.04	98.21	6	3	
99.85	00.02	2d		
5304.17	04.34	2		
07.82	07.99	3		
09.66	09.83	4	1	
11.54	11.71	6	4	
24.28	24.46	4	2	

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Hafnium

5346.30	46.48	3	2
48.44	48.62	3	1
54.74	54.92	6	2
58.34	58.52	2	
73.88	74.07	6	3
83.06	83.25	2	
89.39	89.59	4.5	1
91.32	91.52	2d	1
98.70	98.90	1d	
5404.46	04.66	4	1
23.98	24.18	3	1
35.77	35.98	2	
38.76	38.97	4.5	2
44.03	44.24	4	2
52.88	53.09	5.5	2
63.31	63.52	6	3
97.24	97.45	3	1
5510.10	10.31	3	
10.40	10.61	3	2
24.37	24.58	4	3
30.28	30.49	2	
38.07	38.28	4d	1
50.58	50.79	6	4
52.10	52.31	6	4
75.85	76.07	4.5	2
90.73	90.95	2	1
5600.79	01.01	2	
13.28	13.50	5.5	3
13.96	14.18	3	
28.18	28.40	2	

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50 Hafnium

5650.72	50.94	3	1
54.54	54.76	3	1
62.06	62.28	2	
98.08	98.30	4	2
5713.26	13.48	4	2
19.20	19.42	6	4
20.12	20.34	3	
34.59	34.81	3	1
48.71	48.93	3	2
65.31	65.53	2d	2d
65.96	66.18	2	
67.16	67.38	3	2
5809.50	09.72	3	
17.43	17.65	2	1
38.87	39.09	2	
42.22	42.44	4.5	1
45.86	46.08	3	
47.74	47.96	2	
83.66	83.88	3	1
90.48	90.70	4	
5902.91	03.13	6	3
26.50	26.72	2	
33.72	33.95	4	3
74.30	74.52	4.5	3
78.66	78.88	4	2
92.98	93.20	2	1
6016.78	17.00	3	2
43.22	43.43	3d	1
54.09	54.30	2d	1
98.67	98.88	4.5	2

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Hafnium

6118.20	18.40	2	.1
85.15	85.35	5	
6209.47	09.67	2	
10.74	10.94	3	
16.80	17.00	3	
38.51	38.71	3	
48.92	49.12	4	
6311.78	11.99	2	
38.16	38.37	3	
86.36	86.57	5	
6409.56	09.77	2	
31.8	32.0	2	
49.9	50.1	2	
57.0	57.2	2	
86.5	86.7	2	
6556.6	56.8	2	
58.0	58.2	3	
67.5	67.7	2	
87.2	87.4	4	
6624.4	24.6	2	
44.7	44.9	6	
47.0	47.2	4	
56.7	56.9	2d	
59.5	59.7	2d	
91.0	91.2	2	
6713.5	13.7	4	
34.8	35.0	2	
47.6	47.8	3	
54.6	54.8	5	
89.4	89.6	6	

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Hafnium

6819.0	6
38.6	3
58.7	3
6911.4	3
79.6	2
80.9	4
7030.3	2
63.7	5
7119.5	2
31.8	6
7237.1	5
40.8	5

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Wave Length — Zinc (Zn)

I.A.	Row.	Arc	Spark	Series	
4680				1^3P-1^3S	Zn not enhanced
4722				1^3P-1^3S	Zn " "
4810		10	20	1^3P-1^3S	Zn " "
4912		10	20		
4924		10	20		
3988					Zn + Lockyer, Steinhauser
3989					Zn + " "
4148					Zn + " "
4866					Zn + " "
4879					Zn + " "
4912					Zn + " "
4924					Zn + " "
6214.65	14.86	8	4	2^3P-m^3D?	Zn + 1
5894.37	94.59	8	4	2^3P-m^3D?	Zn +

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Silver (Ag)

3968.1	68.3	—	4
4085.8	86.0	—	4
4210.71	10.87	—	6
12.02*	12.18	10	10
43 11.07*	11.23	4	4
46 77.9	78.1	4	4
5521.03	21.25	—	4
52.57	52.79	—	4
5623.12	23.34	—	4

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Tin (Sn)

3907.2	07.4	–	4
45 24.74	24.91	10	20
5332.8	33.0	–	20
5562.5	62.7	–	30
89.2	89.4	–	20
5799.4	99.6	–	20

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62

Yttrium (Y)

3950.35 50.50

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Vanadium + (From Meggers, ZfP 33, 522, 1925)
all lines of intensity 5 and greater

Wave Length		Int.	Series	Arc	Spark (Exner + Hoochek)	
I.A.	Row.	7	$a^3G_4 - {}^3F_4$			
3863.81	63.95			2	4	
66.76	66.90	5	$^3P_1 - {}^5D_2$	–	3	
84.85	84.99	6	$a^3G_3 - {}^3F_3$	1	2 r	
96.147	96.291	10	$^3P_0 - b^3D_1$	3	3	
3929.736	29.877	5	$^3P_1 - b^3D_1$	1	3	
51.976	52.118	40	$^3P_2 - b^3D_3$	2	15	
68.095	68.237	15	$^3P_0 - a^3D_1$	2	4	
77.74	77.88	10	$^3P_2 - b^3D_2$	–	4	
4036.772	36.919	9	$^3P_2 - a^3D_2$	1	4	
4164.03	64.19	5	$b^3G_4 - {}^3F_4$	–	–	
78.39	78.55	10	$^5P_2 - {}^5D_3$	1	4	
4202.34	02.50	35	$^5P_3 - {}^5D_4$	1	8	
04.20	04.36	8	$^5P_3 - {}^5D_3$	~~r~~	2	
05.087	05.248	30	$^5P_2 - {}^5D_2$; $b^3G_4 - {}^3F_3$	1	10	
09.80	09.96	12	$^5P_1 - {}^5D_1$	8	8	
25.23	25.39	20	$b^3G_3 - {}^3F_2$	1	6	
32.05	32.21	15	$^3S_1 - {}^3P_2$	–	3	
4301.16	01.32	7	$^3S_1 - {}^3P_0$	–	2	
3093.09		100	$^5F_5 - {}^5G_6$			III E r
3102.301		80	$^5F_4 - {}^5G_5$			III E r
3110.710		70	$^5F_3 - {}^5G_4$			III E r
3118.382		60	$^5F_2 - {}^5G_3$			III E r
3121.144		25	$^5F_5 - {}^5G_5$			IV E
3125.286		50	$^5F_1 - {}^5G_2$			III E r
3126.221		25	$^5F_4 - {}^5G_4$			III E
3130.270		30	$^5F_3 - {}^5G_3$			III E
3133.336		25	$^5F_2 - {}^5G_2$			III E
3145.344		6	$^5F_3 - {}^5G_2$			IV E
3145.979		4	$^5F_4 - {}^5G_3$			V E

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Rowland	Int.	Rem.	Blend and Spot.	Chromosphere		Int.	
			-				
-			-	-			
3866.960	2	C-	-	3866.93	C-V	1	
3884.986	0		-	-			
3896.279	0	V?	3896.66 Fe $^5D-^5D'$	3896.34	Er-V	1	
3929.864	0Nd?	Mn?	-	-			
3952.103	2	Mn-	Co	3952.11	V	2	
-			+				in wing of H line
3977.891	6	Fe	3977.9*	3977.91	Fe-V	2	
4036.923	1		-	4036.92	V	0	
4164.180	0		-	-			
4178.547	0			-			
4202.514	0Nd?		Fe	4202.59	V-C	0	
4204.359	0	Cr		-			
4205.239	1		4205.0* (5.5)	4205.22	V-Eu	8	
4209.985	1	V	4209.2* (4.5)	4209.89	V-Cr-	0	Zr+
4225.378	0		4225.2* (3)	4226.45	V-Sc-Pr	2	
4232.21	000N		4232.0* (1.8)	4232.60	V-Nd	1	
4301.158	2	Ti		4301.24	Ti	2	
3093.229	2N						
3102.404	3	V					
3110.810	5Nd?	Ti, V					
3118.498	3	V					
3121.270	4	V					
3125.399	5						
3126.319	5	V, Fe					
3130.380	3	V					
3133.449	2	V					
3145.484	3						
3146.591	1	Zr					

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Wave length I.A.	Rowland	Int.	Series	Arc	Spark	Re
3164.84		6	$a^3F_3 - {}^3\bar{F}_4$		VE	3
68.140		5	$a^3F_2 - {}^3\bar{F}_3$		VE	3
87.718		20	$a^3F_2 - {}^3\bar{F}_2$		VE	3
88.520		25	$a^3F_3 - {}^3\bar{F}_3$		VE	3
90.688		30	$a^3F_4 - {}^3\bar{F}_4$		VE	3
3208.353		10	$a^3F_3 - {}^3\bar{F}_2$		VE	3
14.752		10	$a^3F_4 - {}^3\bar{F}_3$		VE	3
17.113		30	$b^3\bar{G}_5 - {}^3\bar{H}_6$		–	
37.870		25	$b^3\bar{G}_4 - {}^4\bar{H}_5$		VE	
49.567		8	$b^3\bar{G}_5 - {}^3\bar{H}_5$		–	
54.764		25	$b^3\bar{G}_3 - {}^3\bar{H}_4$		–	
63.31		6	$b^3\bar{G}_4 - {}^3\bar{H}_4$		–	
67.705		50	$a^3F_2 - {}^3G_3$		VE	
71.125		60	$a^3F_3 - {}^3G_4$		VE	
3276.128		70	$a^3F_4 - {}^3G_5$		VE	
89.389		7	$a^3F_3 - {}^3G_3$		VE	
3298.738		10	$a^3F_4 - {}^3G_4$		VE	
3479.836	9.954	5	$a^3F_2 - {}^5D_2$		–	
85.928	6.076	9	$a^3F_3 - {}^5D_3$		–	
93.168	3.316	6	$a^3F_2 - {}^5D_1$		VE	
3504.441	4.589	15	$a^3F_3 - {}^5D_2$		VE	
17.305	7.453	30	$a^3F_4 - {}^5D_3$		VE	
20.025	0.173	7	$a^3F_2 - b^3D_2$		VE	
24.718	4.866	8	$a^3F_3 - b^3D_3$		VE	
30.776	0.924	25	$a^3F_2 - b^3D_1$		VE	
45.203	5.351	30	$a^3F_3 - b^3D_2$		VE	
56.800	6.947	40	$a^3F_4 - b^3D_3$		VE	
60.586	0.733	5	$a^3F_3 - a^3D_3$		–	
3566.176	6.323	8	$a^3F_2 - a^3D_2$		–	

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Rowland	Int.	Rem.	Chromosphere		Int
3164.946	1				
3168.263	2				
3187.824	2	V			
3188.656	6d?	-, Fe			
3190.795	2	V			
3208.464	1	V			
3214.889	3	Ti, -			
3217.210	1				
3237.967	2 Nd?	V			
3249.654	00				
3254.984	5d?	V, Fe			
3263.355	0	V, Co			
3267.834	6	V			
3271.125	5	Ni, Co, Zr, V			
3276.259	5d?	V			
3289.568	3	V			
3298.869	3	V			
3479.969	0		-		
3486.041	5	Ni	3486.07	V-Ni	0
3493.316	0 N		3493.27	V	1
3504.581	2	Fe, V	3504.58	V	2
3517.453	3	-, V	3517.48	V	2
3520.168	2		-		
3520.886	1		-		
3530.919	3		3530.86	V	2
3545.336	4	-, V	3545.33	V	3
3556.947	4	Fe	3556.84	V, Zr, Fe	4
3560.729	1		-		
3566.314	2		3566.28	V	1

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Wave Length I.A.	Rowland	Int.	Series	Arc	Spark
3589.753	9.899	30	$a^3F_2 - a^3D_1$		VE
92.015	2.161	30	$a^3F_3 - a^3D_2$		VE
3593.327	3.473	30	$a^3F_4 - a^3D_3$		VE
3727.348	7.490	35	$b^3F_4 - {}^3\overline{F}_4$		VE
3750.873	1.017	25	$b^3F_3 - {}^3\overline{F}_3$		VE
60.230	0.374	6	$b^3F_4 - {}^3\overline{F}_3$		—
70.976	1.120	20	$b^3F_2 - {}^3\overline{F}_2$		VE
3778.359	8.501	5	$b^3F_3 - {}^3\overline{F}_2$		VE

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Rowland	Int.	Rem.	Chromosphere	Rem.	Int.	
3589.908	sd?		3589.86	V-Sc	8	
3592.161	2	V?	3592.16	V	3	
3593.481	3	Fe	3593.48	V, Cr	4	
3727.488	1	~~V~~	3727.53	V –	2	
3751.015	2		–			(HK)
3760.364	1		–			
3771.120	2		–			
3778.463	3	Fe	3778.44	Fe-V-Ni	1	

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Zinc + (G. v. Salis Ann. d. Physik, 76, 145, 1924)

I.P.

Int.	λ I.A.	ν	series	λ Corr. to Rowland
6	7757.97	12886.43	$5p_1 - 6s$	
10	7732.63	12928.66	$5s - 5p_2$	
5	7613.02	13131.78	$5p_2 - 6s$	
15	7588.61	13174.02	$5s - 5p_1$	
20	7478.77	13367.50	$4p_1 - 3d_1$	
0	6842.32	14610.91	$5d_1 - 6f_2$	
8	6831.21	14634.67	$5d_2 - 6f_2$	
9	6825.87	14646.11	$5d_1 - 6f_1$	
15	6482.98	15420.75	$4f - 6f'$	6482.10
11.79 12	6214.65	16086.56	$4p_1 - 3d_2$	6214.85
10	6111.56	16357.91	$5p_1 - 5d_2$	6111.76
20	6102.54	16382.11	$5p_1 - 5d_1$	6102.74
15	6021.26	16603.24	$5p_2 - 5d_2$	6021.48
11.90 20	5894.43	16960.48	$4p_2 - 3d_2$	5894.65
2	5586.22	17896.23	$5d_1 - 7f_1$	5586.43
0	5585.21	17899.46	$5d_1 - 7f_2$	5585.42
1	5577.82	17923.21	$5d_2 - 7f_2$	5578.03
3	5357.59	18659.92	$4f - 7f'$	5357.77
30	4923.98	20303.12	$4d_1 - 4f$	4924.16
25	4911.63	20354.16	$4d_2 - 4f$	4911.81
7	4119.38	24268.66	$5p_1 - 7s$	4119.53
5	4078.14	24514.07	$5p_2 - 7s$	4078.29
6	3842.26	26018.97	$5p_1 - 6d_2$	3842.40
15	3840.34	26031.98	$5p_1 - 6d_1$	3840.48
10	3806.39	26264.16	$5p_2 - 6d_2$	3806.53

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Rowland

6483.027	Ni.	1
6214.885		000N
6111.872	V	0d?
6102.635		0000Nd?
–		
5894.605	A(uv)	0
5586.497		000
5585.397		000
–		
–		
4924.107	Fe(+)	5
4911.717		0
4119.550	Fe	1
4078.318		00Nd?
3842.354	-C?	0d?
3840.440	V	0N
3806.511	C	0
3806.586	C	0

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Terms for 2w +

II N-S. $4p_i - ms$

$4p_1 = 95536.52$
$4p_2 = 96410.05$
$5s = 56454.32$

II N-S $5p_i - ms$

$5p_1 = 43280.30$
$5p_2 = 43525.38$
$6s = 30393.87$
$7s = 19011.64$
$8s = 13014.23$
$9s = 9468.07$

H-S $4s - mp_i$

$4s = 14489$ a
$4p_1 = 95536.52$ 23
$4p_2 = 96407.02$

H-S $5s - mp_i$

$5s = 56454.32$
$5p_1 = 43280.30$
$6p_1 = 24931.55$
$7p_1 = 16219.03$
$5p_2 = 43525.66$
$6p_2 = 25002.43$

I N-S $4p_i - md_j$

$4p_1 = 95536.52$
$4p_2 = 96410.55$
$4d_1 = 47729.49$
$4d_2 = 47982.69$

I N-S $5p_i = md_j$

$5p_1 = 43280.30$
$5p_2 = 43525.38$
$5d_1 = 26898.19$
$5d_2 = 26922.39$

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$6d_1 = 17248.32$
$6d_2 = 17261.33$
$7d_1 = 12003.03$
$7d_2 = 12010.17$
$8d_1 = 8834.48$
$8d_2 = 8838.99$
$9d_1 = 6773.82$
$9d_2 = 6777.03$

B-S $4d_i - mf_i$

$4d_1 = 47931.42$
$4d_2 = 47982.20$
$4f_1 = 27628.30$
$4f_2 = 27628.04$
$5f_1 = 17691.71$
$5f_2 = 17681.10$
$6f_1 = 12252.08$
$6f_2 = 12287.28$

B-S. $5d_i$

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Nitrogen #. C.C. Kiess J.O.S.A. 11, 1, 1925
Infrared lines in N- filled discharge tube.
C.C. Kiess. Sci, 60, 249, 1924
" " in arc spectrum. Ib., Pub. Am. Ast. Soc. 4, 170, 363, 1923
" " " spark .. Merrill ApJ 51, 236, 1920
N+ gives odd multiplicities
N " even

Quartet PD multiplets

	$n D_1$	$n D_2$	$n D_3$	$n D_4$
	22572.82	22550.23	22512.88	22461.90
$2P_3$		—	8718.99(1)	8680.35(3)
33979.01				
$2P_2$				
34025.72	8729.07($\frac{1}{2}$)	8711.87(1)	8683.61(2)	
$2P_1$				
34059.47	8703.42(1)	8686.38(1)		
$4P_3$		—		
7417.09			6622.55(00)	6644.97(7)
$4P_2$				
7487.21	6626.98(0)	6636.94(0)	6653.46(4)	
$4P_3$				
7531.55	6646.52(2)	6656.53(0)		
$5P_3$		—	—	5616.84(4)
4632.36				
$5P_2$				
4734.41	—	5611.36(00)	5623.22(3)	
$5P_2$				
4779.07	5618.18(00)	5625.40(00)		

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Quartet PP' multiplets

		P'_1	P'_2	P'_3
		21668.50	21850.12	21811.76
$2P_3$	38979.01		8242.47(3)	8216.46(5)
$2P_2$	34025.72	8223.28(3)	8210.94(2)	8185.05(3)
$2P_1$	34059.47	8200.59(1)	8188.16(3)	
$4P_3$	7417.09		6926.70(2)	6945.18(3)
$4P_2$		—	—	—
$4P_1$		—	—	
$5P_3$			—	5829.52(2)
$5P_2$		—	—	—
$5P_1$		—	—	++

Quartet system PS triplets

		nP_1	nP_2	nP_3
		7423.88(3)	7442.56(4)	7468.74(5)
S_2		—	—	—
20593.28		—	6303.74(00)	6275.43(0)

Quartet DF and DD' multiplets.

		nD_1	nD_2	nD_3	nD_4
F5	7040.58				6482.74(9)
F_4	7096.64			6484.88(8)	—
F_3	7131.34		6438.77(4)	6499.51(1)	—
F_2	7159.08	6481.73(3)	6491.24(1)	—	
D'_4	6942.35			6420.63(2)	6441.70(5)
D'_3	7057.19		6452.76(1)	6468.30(1)	—
D'_2	7123.61	6471.02(0)	6480.53(0)	—	
D'_1	7069.48	6448.41(1)	6457.89(0)		

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N♯. Doublet system multiplets.

		P_1	P_2
		45083.12	45000.00
$a P'_2$	33415.16	8568.04 (1)	8629.61 (3)
$a P'_2$	33458.89	8594.34 (2)	8656.32 (1)
$b P'_2$	18900.24	3818.19 (1)	3830.39 (9)
$b P'_1$	18926.25	3822.00 (5)	3834.20 (4)
D_3	20675.59		4109.94 (10)
D_2	20699.12	4099.96 (9)	4113.92 (5)
S_1	24742.44	4914.94 (4)	4935.03 (9)

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	Nitrogen			Meggers' chart		Rowland	
$nD_1 - 2P_2$	8729.07	.5		8728.8	s		
$nD_3 - 2P_3$	8718.99	1		8718.6	s		
	8711.87	1		8711.1	s		
	8703.42	1		-			
	8686.38	1		-			
	8683.61	2		-			
	8680.35	3		8680.7	v.w.		
$P_2 - 2P_2'$	8656.32	1		-			
	8629.61	3		-			
	8594.34	2		8594.8	v.w		
	8568.04	1		-			
$P_2' - 2P_3$	8242.47	3		8242.0	vw.		
	8223.28	3		8223.9	vs		
	8216.46	5	x	-			
	8210.94	2		8210.2	s		
	8200.59	1		8200.7	v.s.		
	8188.16	3		-			
$nP_1 - S_2$	7468.74	5	x	-			
	7442.56	4		7442.9	v.s.		
	7423.88	3		7423.4	vs		
	6303.74	00		6303.9	vw		
	6275.43	0		6275.2	vw		
	6945.18	3		6945.1	vs	6945.477	4 -
$P_2' - 4P_3$	6926.70	2		6926.2	s	6926.363	0 -
$nD_2 - 4P_3$	6656.53	0		-		6654.150	00 -
	6653.46	4		6653.9	vw	↓	↓
	6646.52	2		-			
	6644.97	7	x	-			
	6636.94	0		-			
	6626.98	0		6626.4	vw	-	
	6622.55	00		-			

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Meggers		
8729.124	ooo	
—		
—		
8703.748	ooo Mn	
8686.300	oo	-
—		
8683.316	ooo	-
—		
—		
—		
—		
8242.359	ooo-o	A
—		
—		
—		
8200.700	1-3	A
—		
—		
—		
7423.530	1	Si

See Saha Nat. 117, 268, 1926. this comparison does not bear out the identification of neutral N in the Sun.

See H.B. 835, 1926

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Nitrogen, continued

			Rowland	M	
$^4D_3 - {}^4F_5$	6499.51	1	Meggers	6	
	6491.24	1			
	6484.88	8	6484.8	-	
	6482.74	9	6482.8	-	Ni
	6481.73	3		-	
	6438.77	4			
$^4D_2 - {}^4D_2'$	6480.53	0			
	6471.02	0			
	6468.30	1			
	6457.89	0			
	6452.76	1			
	6448.41	1			
	6441.70	5			
	6420.63	2			
$^4P_3' - 5^4P_3$	5829.52	2			
	5625.40	00			
	5623.22	3			
	5618.18	00			
	5616.54	4			
	5611.36	00			
$^2P_2 - {}^2S_1$	4935.03	9		-	
	4914.92	4			
$^2P_2 - {}^2D_2$	4113.92	5		-	
	4109.94	10		-	
^2P	4099.96	9			
$^2P_2 - 6^2P_1'$	3834.20	4			
	3830.39	9			
	3822.00	5			
	3818.19	1			

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Ionized oxygen

Series	Wave Length	Intensity	λ ε Orionis	Int ε Ori	β Orionis S.P.C. 1908
$2^2P_2 - 2^2S_1$	6721.35	5			
	6654.77	1			
$2^2P_1 - 2^2S_1$	6640.90	4			
$a^2P'_2 - a^2P''_2$	5206.73	5			
$a^2P'_1 - a^2P''_2$	5190.56	3			
$a^2P'_2 - a^2P''_1$	5176.00	2			
$a^2P'_1 - a^2P''_1$	5160.02	4			
$a^2P'_2 - B^2D'_2$	4955.78	3			
$a^2P'_2 - B^2D'_3$	4943.06	7			
$a^2P'_1 - B^2D'_2$	4941.12	5			
	4924.60	6	4924.1	–	
	4906.88	5			
	4890.93	4			
$B^2P'_2 - C^2D'_3$	4871.58	5			
	4864.95	3			
$B^2P'_1 - C^2D'_2$	4861.03	3	4861.5	10	
$^4S_2 - {}^4D'_{21}$	4856.82	3			
$^4S_2 - {}^4D'_3$	4856.49	2			
$^4S_2 - {}^4X_3$	4845.01	1			
	4843.26	1n			
	4752.70	2			
	4751.34	4			
	4744.85	0			
	4741.71	3			
	4710.04	5	4710.3	–	
	4705.36	8	4705.6	1	
	4703.18	3			

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λ So Hβ 28

4941.6 2

4906.3 1

4889.0 "

(4861.5) 40

4705.9 0

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Ionized oxygen (continued)

Series	Wave Length	Intensity	λ ε Orionis	Int ε Ori
$B^2P'_2 - B^2P''_1$	4701.76	0		
$B^2P'_2 - B^2P''_2$	4701.23	2		
	4699.21	7	4699.4	1
$a^4P_3 - {}^4D_2$	4696.56	2		
$B^2P'_1 - B^2P''_1$	4691.47	1		
$B^2P'_1 - B^2P''_2$	4690.97	0		
$a^4P_3 - {}^4D_3$	4676.246	8	4676.3	3
$a^4P_2 - {}^4D_1$	4673.75	4		
	4669.53	0		
$a^4P_2 - {}^4D_2$	4661.650	9	4661.8	3
$a^4P_1 - {}^4D_1$	4650.853	6	4650.8	8
$a^4P_3 - {}^4D_4$	4649.148	10	4649.2	—
$a^4P_2 - {}^4D_3$	4641.827	9	4641.9	3-4
$a^4P_1 - {}^4D_2$	4638.865	6	4639.0	1
	4610.14	3n	4609.7	2
	4609.42	4n		
	4602.11	2n	4601.7	<1
	4596.189	8	4596.3	2
	4590.983	9	4591.1	1-2
	4506.50	2n		
	4491.25	3n	4491.0	1
	4489.48	1n	4489.4	—
	4488.09	2n		
	4487.72	0n	4487.6	—
	4477.88	2n	4477.5	1
	4469.32	3	4468.7	—
	4467.88	4		
	4467.55	1		
	4466.32	2n		

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γ Ori B2

4675.3 1

4661.7 1

4649.2 4

4641.1 4

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Ionized oxygen, continued

Series	Wave Length	Intensity	λ ε Orionis	Int ε Ori
	4465.40	4	4465.5	1-2
$2^2P_2 - a^2D_2$	4452.38	6	4452.6	–
	4448.21	6		
	4447.08	1	4447.2	1
	4443.05	5	4442.5	–
$2^2P_1 - a^2D_2$	4416.974	8	4417.0	2
$2^2P_2 - a^2D_3$	4414.888	10	4415.1	2
$a^2D_3 - B^2D'_2$	4406.02	1		
$a^2D_3 - B^2D'_2$	4395.95	7	4396.1	–
	4379.55	2n	4379.8	3
	4378.40	3n		
	4376.15	0n		
	4371.65	2n	4372.2	1
$a^2D_2 - B^2D'_2$	4369.28	4		
$a^4P_3 - {}^4P'_2$	4366.906	7	4367.0	3
$a^2D_2 - B^2D'_3$	4359.38	1		
	4358.40	0		
	4357.25	0		
	4353.60	1n	4354.0	1
$a^2D'_3 - B^2D_3$	4351.275	6	4351.5	2
$a^4P_3 - {}^4P'_3$	4349.435	8	4349.6	3-4
$a^2D'_2 - B^2D_2$	4347.429	5	4347.6	1
$a^4P_2 - {}^4P'_1$	4345.570	7	4345.7	3
	4344.42	0n		
	4343.30	00	4343.2	–
	4342.00	4n		
	4340.36	2n	4340.7	10
$a^4P_2 - {}^4P'_2$	4336.86	6	4337.0	–

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γ Ori

4447.7 2

4417.5 } 2
4415.1 }

4395.7 2
4380.1 0

4367.3 1

4350.1 1

4345.5 0

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Ionized Oxygen, continued

Series	Wave Length	Intensity	λ ε Orionis	Int ε Ori
	4334.29	0n	4334.0	–
	4332.76	1n	4332.9	1-2
$B^2D_2 - C^2D'_2$	4331.89	2		
$B^2D_2 - C^2D'_3$	4331.47	0		
	4331.21	0n	4331.2	–
$B^2P'_2 - B^2S'_1$	4328.62	2	~~4327.6~~	+
$B^2D_3 - C^2D'_2$	4327.89	0		
$B^2D_3 - C^2D'_3$	4327.48	3	4327.6	1
$a^4P_1 - 4P'_1$	4325.77	3	4325.9	1-2
$B^2P' - B^2S'_1$	4319.93	1	4319.8	2
$a^4P_2 - 4P'_3$	4319.647	8		
$a^4P_1 - 4P'_2$	4317.160	8	4317.3	2
	4315.55	0n	4315.1	–
	4313.43	1n	4313.0	–
	4312.10	0n		
	4308.96	1n	4308.1	–
	4307.31	1n		
	4305.53	0		
	4303.82	5n	4304.2	1-2
	4303.00	0n	4303.3	–
	4294.82	3n	4295.0	–
	4292.23	0n	4292.2	–
	4291.25	1n	4290.4	–
	4288.83	1n		
	4285.70	3n	4285.1	1-2 S
	4283.75	0n		
	4282.96	1n		
	4281.40	0n		
	4277.90	1n		

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ζ Ori

4320.7
4318.0 } 2

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Ionized Oxygen, continued

Series	Wave Length	Intensity	λ ε Orionis	Int ε Ori	
	4277.40	1n	–		
	4276.71	1n	4276.2	2-3	–
	4275.52	4n			
	4273.17	0n			
	4253.98	8n	4253.98	3	S
$B^2D_2 - B^2P''_1$	4196.72	1	4196.2	1	N?
$B^2D_3 - B^2P''_2$	4192.50	2			
	4189.793	10	4190.1	1-2	O
	4185.453	8	4185.7	2-3	O
	4169.23	4	4169.1	1-2	Ast
	4156.54	3	4156.7	–	O
	4153.310	7	4153.7	2	O,S
	4146.09	3	4146.0	1	N
	4145.90	0	4145.5	–	S
	4143.77	2	4143.9	5	Ast
	4143.52	1			
	4142.24	0	4142.8	–	S
	4142.00	1			
	4140.74	0			
	4132.82	6			
	4129.34	2	4129.8	–	–
	4121.48	4			
$4P'_3 - {}^4D'_2$	4120.55	2			
$4P'_3 - {}^4D'_3$	4120.30	3			
$4P'_3 - {}^4D'_4$	4119.222	8	4119.5	0	–
	4113.82	1			

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1924phae.proj.1096

γ Ori

4254.1 2

469. 1.

4186.2 1

4152. 1

4204.7 2

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Ionized oxygen cont. ζ Ori

Series $^4P'_3$-^4X	4112.04	4	4112.3	–	0
	4110.80	3	4111.1	–	0
	4110.20	1			
	4108.75	0n			
	4107.07	1n			
$^4D_4$-$^4F_4$	4106.03	0			
$^4P'_2$-$^4D'_2$	4105.001	7	4105.2	–	0
$^4P'_2$-$^4D'_3$	4104.74	5			
	4103.01	5			
	4098.27	0n			
$^4P'_1$-$^4D'_1$	4097.32	1			
$^4P'_1$-$^4D'_2$	4097.25	4n			
$^4P'_2$-$^4X_3$	4096.54	3			
	4095.63	0n			
$^4D_3$-$^4F_2$	4094.18	0			
$^4D_4$-$^4F_4$	4092.94	5	4093.2	1–2	0
	4089.28	4n	4089.1	9	Si
	4087.16	2n			
$^4D_3$-$^4F_3$	4085.12	3	4085.4	1	0
	4084.66	1			
	4083.90	2n			
	4079.00	0	4079.1	1	0
$^4D_2$-$^4F_2$	4078.86	4			
$^4D_4$-$^4F_5$	4075.869	10	4076.1	4	0
$^4D_3$-$^4F_4$	4072.156	8	4072.4	2	0
	4071.20	0			
$^4D_2$-$^4F_3$	4069.903	6	4070.0	–	0
$^4D_1$-$^4F_2$	4069.635	10 4	4069.7	4	0 *
	4062.90	8 1n			
	4060.98	9 2n			

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	4060.58	3n			
	4054.60	0n			
	4048.22	1n			
	4041.20	0n			
	4035.00	0n			
	4026.40	0n			
	4024.04	1n			
	4021.90	0n			
	3985.37	0			
$2^2P_2 - a^2P'_1$	3982.725	5	3982.9	1	0
$2^2P_2 - a^2P'_2$	3973.266	10	3973.4	1-2	0
	3967.44	1			
	3963.13	0			
$2^2P_1 - a^2P'_1$	3954.388	7	3954.6	1-2	0
$2^2P_1 - a^2P'_2$	3945.050	5	3945.3	—	0
$a^2D'_2 - b^2P'_1$	3919.279	6	3919.2	1-2	N
$a^2D'_2 - b^2P'_2$	3912.088	2	3912.2	—	0
$a^2D'_3 - b^2P'_2$	3911.957	10			
	3907.45	4			
	3896.30	1			
	3893.53	2			
$^4D_4 - {}^4D'_3$	3883.15	3			
	3882.45	1			
$^4D_4 - {}^4D'_4$	3882.194	7			
$^4D_4 - {}^4X_3$	3875.82	4			
	3874.10	2			
	3872.45	1			

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Preliminary List of weakened spot lines not assigned by Rowland

Rowland	I.A.	Note	Int.	I.A.	Wave Number	
4748.325 ~~438~~		? Fe	4			
4750.139		? Fe	~~1~~			
4848.438			2			
4852.743			2			
4864.505			1			
4876.586			1			
4914.150			2			
4995.586			00			
5132.843			00			
5140.992			00			
~~5269~~						
5275.454			1			
5414.279			00			
5686.429			0			
5747.890			1			
5793.292			3			
5798.077			3			
5929.100			00			
6084.325			0			
6092.133			1			
6125.236			1			
6131.785			0			
6132.070			0			
6142.700			1			
6145.228			2			
✓ 6149.458		Fe+ ^2D-^1P	2			one member of ^2D-^1P, at 6239.95, missing.
✓ 6230.312		Ni +	0			
6237.534			3			
✓ 6238.598		Fe+ ^2D-^1P	2			

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Rowland	Note	Int.	I.A.	Wave Number
6244.033		2		
6244.335		2		
✓ 6247.774	Fe+ $2^4D-14D'$	2		
6286.359		0		
6347.310		2N		
6364.920		0		
6383.932		0		
6385.950		0		
6392.751		0		
✓ 6407.515	Fe+ $2^4D-14D'$	0N		
✓ 6456.603	Fe+ $2^4D-14D'$	3		
6491.800		1		
6516.311s		2		
6527.444		1		
6319.460				
6331.067	Fe+	2		
6339.096	Fe+	2		

Has the 2^4D-14P multiplet of Fe+ been terrestrially observed?

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J.W.A.S. 16, 143, 1926

Neutral Ruthenium. W.F. Meggers and O. Laporte

Multiplets between 3800 (some lines at least) and red.

Wave Length	Int.	Series
3799.34	8a	$^5F_5 - {}^5D_4$
3979.44	5	$^5F_4 - {}^5D_4$
4127.46	3	$^5F_3 - {}^5D_4$
3798.90	8a	$^5F_4 - {}^5D_3$
3933.55	4	$^5F_3 - {}^5D_3$
4032.21	3	$^5F_2 - {}^5D_3$
3790.50	10a	$^5F_3 - {}^5D_2$
3882.00	3	$^5F_2 - {}^5D_2$
3942.06	3	$^5F_1 - {}^5D_2$
3786.05	10a	$^5F_2 - {}^5D_1$
3843.07	3	$^5F_1 - {}^5D_1$
3777.58	3a	$^5F_1 - {}^5D_0$
5309.26	20	$^5D'_4 - {}^5D_4$
5636.23	35	$^5D'_3 - {}^5D_4$
4992.73	7	$^5D'_4 - {}^5D_3$
5280.81	4	$^5D'_3 - {}^5D_3$
5456.13	8	$^5D'_2 - {}^5D_3$
5026.17	8	$^5D'_3 - {}^5D_2$
5184.72	2	$^5D'_2 - {}^5D_2$
5304.85	7	$^5D'_1 - {}^5D_2$
5014.95	8	$^5D'_2 - {}^5D_1$
5127.25	5	$^5D'_1 - {}^5D_1$
5011.22	9	$^5D'_1 - {}^5D_0$
?		$^5D'_0 - {}^5D_1$

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16, 26

λ	Int.	Series
5171.02	40	$^5D'_4 - {}^5F'_5$
4869.16	25	$^5D'_4 - {}^5F'_4$
5142.76	8	$^5D'_3 - {}^5F'_4$
4669.96	8	$^5D'_4 - {}^5F'_3$
4921.08	12	$^5D'_3 - {}^5F'_3$
5072.97	7	$^5D'_2 - {}^5F'_3$
4794.38	4	$^5D'_3 - {}^5F'_2$
4938.43	10	$^5D'_2 - {}^5F'_2$
5047.30	6	$^5D'_1 - {}^5F'_2$
4874.33	3	$^5D'_2 - {}^5F'_1$
4980.35	9	$^5D'_1 - {}^5F'_1$
?		$^5D'_0 - {}^5F'_1$

4385.40	4	$^5D'_4 - {}^5G_5$
?		$^5D'_4 - {}^5G_4$
4690.11	5	$^5D'_3 - {}^5G_4$
4336.42	2	$^5D'_4 - {}^5G_3$
4552.10	5	$^5D'_3 - {}^5G_3$
4681.79	10	$^5D'_2 - {}^5G_3$
4466.34	1	$^5D'_3 - {}^5G_2$
4891.11	6	$^5D'_2 - {}^5G_2$
?		$^5D'_1 - {}^5G_2$

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Ru I (continued)

λ	Int.	Series
5699.06	20	$^5P_3 - {}^5D_4$
5335.92	10	$^5P_3 - {}^5D_3$
5136.55	25	$^5P_2 - {}^5D_3$
5076.07	5	$^5P_3 - {}^5D_2$
4895.28	6	$^5P_2 - {}^5D_2$
5155.12	12	$^5P_1 - {}^5D_2$
4743.66	1	$^5P_2 - {}^5D_1$
4987.25	5	$^5P_1 - {}^5D_1$
4877.41	3	$^5P_1 - {}^5D_0$

5195.01	10	$^5P_3 - {}^5F_4'$
4968.87	7	$^5P_3 - {}^5F_3'$
4795.57	6	$^5P_2 - {}^5F_3'$
4839.75	4	$^5P_3 - {}^5F_2'$
4675.19	1	$^5P_2 - {}^5F_2'$
4911.58	3	$^5P_1 - {}^5F_2'$
4617.66	3	$^5P_2 - {}^5F_1'$
4848.17	2	$^5P_1 - {}^5F_1'$

4733.47	12	$^5P_3 - {}^5G_4$
4593.08	1	$^5P_3 - {}^5G_3$
4444.50	3	$^5P_2 - {}^5G_3$
4505.64	1	$^5P_3 - {}^5G_2$
4362.71	1	$^5P_2 - {}^5G_2$
4567.92	1	$^5P_1 - {}^5G_2$

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λ	Int.	Series
4080.63	20	$^3F_4 - {}^3D_3$
4354.14	5	$^3F_3 - {}^3D_3$
4546.93	1	$^3F_2 - {}^3D_3$
4144.18	10	$^3F_3 - {}^3D_2$
4318.43	3	$^3F_2 - {}^3D_2$
4076.75	8	$^3F_2 - {}^3D_1$

4199.91	10a	$^3F_4 - {}^3F'_4$
4490.22	3	$^3F_3 - {}^3F'_4$
3867.82	8	$^3F_4 - {}^3F'_3$
4112.76	8	$^3F_3 - {}^3F'_3$
4284.34	5	$^3F_2 - {}^3F'_3$
3984.86	10	$^3F_3 - {}^3F'_2$
4145.75	8	$^3F_2 - {}^3F'_2$

4554.52	50a	$^3F_4 - {}^3G_5$
4217.28	5	$^3F_4 - {}^3G_4$
4510.12	8	$^3F_3 - {}^3G_4$
3950.22	3	$^3F_4 - {}^3G_3$
4206.02	5	$^3F_3 - {}^3G_3$
4385.66	4	$^3F_2 - {}^3G_3$

5057.33	30	$^3F_4 - {}^5D_4$
5484.33	10	$^3F_3 - {}^5D_4$
4769.30	9	$^3F_4 - {}^5D_3$
5147.24	10	$^3F_3 - {}^5D_3$
5418.85	6	$^3F_2 - {}^5D_3$

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Ru I, (continued).

λ	Int.	Series
4905.01	4	$^3F_3 - ^5D_2$
5151.06	8	$^3F_2 - ^5D_2$
4983.44	4	$^3F_2 - ^5D_1$
4931.72	0	$^3F_4 - ^5F'_5$
4656.42	3	$^3F_4 - ^5F'_4$
5015.99	0	$^3F_3 - ^5F'_4$
4473.92	4	$^3F_4 - ^5F'_3$
4804.87	8	$^3F_3 - ^5F'_3$
5040.74	6	$^3F_2 - ^5F'_3$
4684.02	10	$^3F_3 - ^5F'_2$
4907.88	8	$^3F_2 - ^5F'_2$
4844.54	9	$^3F_2 - ^5F'_1$
4212.08	10	$^3F_4 - ^5G_5$
4282.20	2	$^3F_4 - ^5G_4$
4584.45	30	$^3F_3 - ^5G_4$
4166.88	3	$^3F_4 - ^5G_3$
?		$^3F_3 - ^5G_3$
4654.31	10	$^3F_2 - ^5G_3$
4370.42	2	$^3F_3 - ^5G_2$
4564.69	5	$^3F_2 - ^5G_2$

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Relative term values for Ru I

$^5F_5$	0.0	$^5G_5$	30279.8
$^5F_4$	1190.8	$^3F'_4$	30348.5
$^5F_3$	2091.7	$^5G_3$	30537.2
$^5F_2$	2713.4	$^5G_2$	30959.0
$^5F_1$	3105.6	$^3D_3$	31044.4
$^3F_4$	6545.0	$^3G_3$	31853.0
$^5D'_4$	7483.0	$^3D_2$	32207.8
$^5P_2$	8044.0	$^3F'_3$	32392.1
$^3F_3$	8084.4	$^3F'_2$	33172.2
$^5D'_3$	8575.6	$^3D_1$	33580.3
$^5P_3$	8771.1		
$^3F_2$	9057.8		
$^5P_1$	9073.2		
$^5D'_2$	9183.8		
$^5D'_1$	9620.4		
$^5D'_0$	?		
$^5D_4$	26312.9		
$^5F'_5$	26816.3		
$^5D_3$	27506.8		
$^5F'_4$	28015.2		
$^5D_2$	28466.0		
$^3G_5$	28495.4		
$^5G_6$	28571.8		
$^5F'_3$	28890.7		
$^5D_1$	29118.9		
$^5F'_2$	29427.5		
$^5D_0$	29570.1		
$^5F'_1$	29693.8		
$^5G_4$	29891.0		
$^3G_4$	30250.4		

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Nickel. Walters JWAS 15, 91, 1925

ν	λ	Int.	Series	Rowland (corr. to I.A.)		
26665.94	3750.09	4	I			
26461.22	3779.08	4	I			
26082.76	3833.95	3	I			
25701.85	3890.77	5	II			
28068.10	3562.64	4	II			
27863.32	3588.85	5	II			
26735.91	3740.29	4	I			
28542.05	3503.59	4	I			
27209.99	3675.15	9	I II			
28364.39	3525.45	10R	II	3524.53	20	Ni
27689.48	3611.48	8u	II			
27239.08	3671.33	5	II			
26856.16	3723.46	6	II			
28373.25	3524.36	3	II	3523.06	1	Ni
27698.25	3623.38	5	II			
27245.92	3670.27	4	II			
28133.39	3554.49	4	I	3553.47	3	Ni
27300.21	3662.98	3	I			
29089.45	3438.26	6R	II	3437.29	5d?	Ni
28879.65	3462.65	10R	II	3461.66	8	Ni
27752.33	3603.29	5	II			
29320.75	3410.55	5	II	3409.56	2	Ni
29115.94	3434.45	9R	II	3433.57	8d?	(Ni;Cu)
28440.94	3516.06	9R	II	3515.06	12	Ni
27988.58	3572.89	7R	II	3571.86	6	Ni
29480.94	3392.02	7R	II			
29296.18	3415.65	10R	II			
28148.83	3552.55	4	I	3551.52	4	Ni
28620.82	3494.06	10R	I I			

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ν	λ	Int	Series
29787.65	3598.68	7R II	
29668.83	3370.54	10R II	
29469.07	3393.89	10R II	
28789.12	3473.47	7R II	
28336.67	3528.99	5 II	
29627.92	3375.19	4R II	
28952.98	3453.88	6R II	
28500.63	3508.69	4 I	
29683.67	3368.86	2 II	
29008.65	3447.25	10R II	
28556.34	3501.75	6 II	
29958.32	3337.97	1 I	
29283.27	3414.88	3R II	
28830.96	3468.49	5 I	
28449.93	3514.95	5 II	
28479.16	3511.26	7R II	
29512.13	3388.36	1 I	
28678.88	3486.89	5 II	
30414.59	3287.89	4 II	
29739.61	3362.48	5R II	
29287.27	3414.35	5R II	
28906.30	3459.35	10R II	
30032.98	3329.67	1 I	
29199.72	3436.46	8R II	
31030.96	3222.59	4R II	
30826.18	3243.99	8R I	
30151.20	3316.58	7R II	
29698.86	3378.51	5R II	
31236.77	3201.35	2 II	

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ν	λ	Int.	series
30561.81		4	II
30109.50		5R	II
29928.54		2	I
31986.16		1	I
31581.35		1	I
30906.29		5R	II
30454.00		3	II
32973.48		3	II
32768.50		10R	II
31641.28		1	II
32102.44		6	II
31269.13		4	II
33112.28		5	II
32907.50		9R	II
32232.49		8R	II
31780.19		4	II
33500.89		4	II
33296.00		10R	II
32620.97		6	II
32168.67		2	I
33406.01		6	II
32731.06		8R	II
32278.73		5	II
31897.82		10R	II
33958.39		6	
33283.41		9R	II
32831.08		4	II
32450.14		6	II
33528.71		6	II

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ν	λ	Int.	series
32695.42		10R	II
35639.11		3	
35434.30		4	
34306.92		2	
36395.98		4	
35720.98		4	
35268.63		3	
34887.62		5	
24009.96		3	II A.
25132.16		3	V ?
26352.79		6	I
25159.34		7	II
15047.78		6	I
12959.43		8	I A.
12835.18		6	III A.
26361.60		4	I
25168.16		4	I
12968.20		1	
26796.71		3	I
13474.69		2	
27109.25		4	II
25910.93		10	II
15799.41		5	II ?
13711.21		8	III A.
27284.18		5	II
26090.79		6	II
15979.33		7	I
14971.79		10	I
13890.92		7	III A.

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ν	λ	Int.	Series
13766.63		8 III A.	
13483.43		6 III A.	
27452.43		2 I	
26259.05		8 II	
16147.50		6 I	
14058.88		6 III A.	
26422.93		8 II	
16311.40		3	
27672.03		7 II	
26478.63		9 II	
16367.08		7 II	
14278.61		4 V ?	
14154.30		4	
26753.22		7 II	
16641.78		3 II	
14145.63		2	
14458.18		7 II	
28175.38		5 II	
28402.81		5 II	
27209.79		7 I II	
17098.04		3	
28696.31		6 R II	
27502.95		3 I	
17391.48		3 II	
16183.93		3	
15302.94		3	
15178.79		5 II	
28814.52		5 II	
27621.11		10 R II	

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ν	λ	Int.	Series
17509.65		6 I	
15921.13		7 V ?	
24225.08		2 I	
28031.72		10 R II	
17420.32		5 I	
15831.78		10 II	
15707.57		I	
29569.59		4 R II	
28376.22		1 I	
30765.69		2 I	
29572.28		10 R II	
19460.83		8 I	
18253.41		10 I	
17372.42		5 II	
16969.94		9 II	
30895.73		1 I	
29702.38		4 R II	
19590.92		4	
17502.50		6 II	
31284.25		2 II	
30090.86		5 II	
19979.44		2	
17841.01		5 I	
31394.33		4 II	
30201.04		2 I	
20084.50		2	
18001.07		4 IV	
17876.94		7 II	
31946.72		3 I	

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ν	λ	Int.	Series
30753.30		3	II
20691.94		2	
18429.25		4	II
32191.97		5	II
30998.54		5R	II
20887.22		2	
19679.64		3	
18391.22		6	II
33422.77		3	II
32229.17		8R	II
22117.75		4	II
34384.21		3	
33190.82		4R	II
23079.50		6	II
20990.97		2	II A
22920.04		9	III
15375.05		1	u
14537.71		3	IV
21017.87		7	III
20543.86		7	III
14036.53		10	IV V
14220.63		5	V
15693.29		4	
14027.82		2	
14211.90		4	
20507.94		2	
13521.37		10	III
20001.44		4	III
20090.33		1	u

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ν	λ	Int.	Series
13285.07		8	III
13469.14		9	III
19854.04		10	III
13124.89		10	III
19604.87		7u	V
13289.16		8	III
14611.38		6	V
14761.74		9	V
12936.95		10	IV
13121.07		9	III
19506.07		6	IV
12773.04		4	
12957.13		7	
19342.00		6	III
12717.36		4	
12901.44		10	V
14373.99		5	V
12442.83		1	
12626.84		7	
13948.93		4	
13919.74		9	V
13920.06		2	
13492.75		9	IV
13643.12		4	
11877.15		2	
13199.27		7	V
13349.74		2	
11574.85		2	
11758.97		2	

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ν	λ	Int	Series
13231.95		9	III
18143.81		5	IV
11348.32		3	
12670.50		3	
12820.24		8	V
11003.96		1	
12476.43		2	
16112.54		3	V
11280.27		4	
11150.23		2	
15973.56		4	V
16062.49		6	V
15585.05		5	
15673.96		7	IV ?
10501.33		2	
22666.85		5u	III
23111.67		4	
22362.69		8	III
22931.53		6	V
21709.51		9	III
22398.07		3	
21924.02		3	
20702.29		7	III
20693.09		5	III
19950.66		3u	
19993.08		5	III
20456.77		3	
21025.63		3	V
17851.69		3u	

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ν	λ	Int.	Series
20296.51		3 III	
20985.12		4 III	
19602.49		7 u V.	
19644.89		2	
19663.83		7 u III.	
20797.24		4 III	
19481.05		3 V	
19944.69		4 III.	
20513.64		5 III.	
19425.36		7 V.	
19614.34		4 V.	
2083.21		3 V.	
19954.33		2	
20074.05		8 III.	
18282.70		2	
18301.63		4 I.	
17872.27		6 III.	
16359.33		4 u V	
17492.69			
16159.16		6 V	
16201.55		3	
16220.39		5 u V.	
17353.77		4 IV.	
15790.60		10 III.	
15813.06		3	
15703.18		7 IV	
16166.59			
15150.57		4 IV	
15937.81		1	

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ν	λ	Int.	Series
13632.17		1	
12713.16		5	
23891.18		4	
22184.94		1	
22262.86		3	
23628.15		3	V.
22728.00		2	
23112.92		3	V
21985.27		4	V
22876.59		3	
21825.07		3	
22716.42		3	V
22528.51		4	V
22207.66		1	
21417.58		3	V
22152.00		3	
20691.94		2	
20212.60		3	
20219.89		2	u
20686.59		3	V
21421.12		3	III
19841.32		4	
19921.51		3	u IV
21127.79		4	IV
19801.01		4	V
20274.96		1	
19312.98		5	V
19310.39		8	V
19312.64		4	u V

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ν	λ	Int.	series.
19869.25		1u	
19519.71		3	
20254.30		4 V	
17771.97		7 V	
18193.65		3 V	
17805.21		6 V	
18539.61		2	
17143.23		5r V	
17221.15		7 V.	
17695.24		4 V	
16668.78		2u V.	
16671.04		3u V	
17877.27		1	
16345.61		8 V	
16425.79		8r V	
17632.00		3	
15192.96		2u	
14153.36		2	
14231.45		8 V	
14233.35		1.	

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Ionized Yttrium, Stronger than 5 between 3000–

λ	Arc	Spark	Series	Rowland.	γ Cyg		
3173.20	3	10r					
3195.75	10	10					
3200.40	10	10					
3203.46	10	10					
3216.83	20	20					
3242.42	20	30					
3328.02	20	30					
3362.14	4	10					
3448.99	5	5					
3496.22	10	10					
3549.17	10	20	$^3D_2-^3D_3$	3549.151	Y? 2		
3584.68	5	10	$^3D_1-^3D_2$	3584.660	Y 2		
3600.92	20	50	$^3D_3-^3D_3$	3600.880	Y 3		
3602.11	10	20	$^3D_1-^3D_1$	3602.060	Y 1		
3611.20	20	30	$^3D_2-^3D_2$	3611.189	Y, Mg? 2		
3628.88	10	10	$^3D_2-^3D_1$	3628.847	Y, Mg? 2		
3633.28	20	30	3	3633.277	Y 2		
3664.78	20	20	$^3D_3-^3D_2$	3664.760	Y 2		
3668.61	3	10r		3668.597	Zr 00		
3710.47	30	100	$^3D_3-^3F_4$	3710.431	Y 3		
3774.52	20	100	$^3D_2-^3F_3$	3774.473	Y 3		
3776.72	5	10		3			
3788.88	20	30	$^3D_1-^3F_2$	3788.839	2		
3818.48	5	10	$^3D_2-^3F_2$	3818.487	1		
3833.09	10	15	$^3D_3-^3F_3$	3833.026	3N		
3950.52	20	20		3950.4975	Y 2	3950.1	
3982.79	20	20		3982.742	Y 3	-	
4177.74	15	50		4177.772	3	4177.7	Fe $^5F-^3F^1$
4204.88	5	5		4204.884	1	4205.0	(V+, Eu)

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Chromosphere

3549.12	Y	2
–		
3600.91	Y	6
3602.03	Y	4
3611.20	Y	3
3628.85	Y	2
3633.27	Y	2
3664.76	Y-Gd	4 (with H_{26})
3668.69	Zr, Y	1
3710.49	Y	8
3774.52	Y	10
–		
3788.80	Y	8
3818.45	Y-V-C	1
3833.24	C–	1
3950.47	Y	4
3982.69	Y-Ti	6
4177.70	Y-Fe	12
4204.84	Y	0

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λ	Arc	Spark	Series	Rowland			γ Cygni	
4309.79	20	20		4309.792		1	4309.2	Vt, Zr+
4358.86	8	10		4358.879	Y, Zr	0	4358.7 *	
4375.12	50	100		4375.103	V, Mn	2	4374.7 *	Sc+
4398.21	10	15	$^3D_2 - {}^3P_1$	4398.178		1	4398.2 *	
4422.80	10	10	$^3D_1 - {}^3P_0$	4422.741	Fe, Y	3	4422.7	
4682.49	4	10		4682.529	– Co	1	4682.5	Ti $^3F - ^3G$
4823.46	3	10		4823.489		000	4824.3	Mn
4840.02	10	10		4840.075		000	4840.4 *	
4855.07	10	30		4855.059	Fe	1	4855.4 *	
4883.89	15	50		4883.867	Yr Earth	2	4882.1 *	
4900.31	10	30		4900.301	Y?	2	4900.1 *	
5087.61	10	10	$^3F_4 - {}^3F'_4$	5087.601	Y?	1		
5205.90	10	10	$^3F_3 - {}^3F'_3$	5205.897	Y	0		
5402.98	4	8		5402.982	Y	0		
5497.60	5	8		5497.624		0000		
5663.15	10	15		5663.155	Ti, Fe, Y	1		

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Chromosphere

4309.78	Y	4
4358.90	Y-h	4
4375.16	Y-Nd	15
4398.32	Y	8
4422.77	Y	3
4682.58	Y-Co	2
-		
-		
4856.00	Y	3?
4883.93	Y	6
4900.32	Y	10
5087.62	Y	3
5205.06	Y Ca-Ti	bd
5402.96	Y	1
5497.61	Y, Cd, Fe	8
5663.15	Y-Ti-Fe	3N

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Ionized Yttrium. (Russell)

E.P.	λ	Int.	Class	Type	Note
0.0	3982.64	100	III	1^3D-1^1D	
	3950.37	150	III		
	3776.57	40	III	1^3D-1P	
	3747.55	20	III		
	3242.28	20			
	3216.67	10			
	3203.32	8		1^3D-2^3P	
	3200.25	8			
	3195.61	8			
	3179.40	5			
	3135.17	25	V	1^3D-1F	
	3095.88	25	V		
0.30	4881.45	(10)			
	4682.31	20	V	$1D-1^3P$	
	4374.95	300	III	$1D-1D'$	
	4177.58	125	III	$1D-1^3F$	
	4124.95	20	III		
	3951.61	8	V	$1D-1^3D'$	
	3930.66	10	V		
	3467.98	20	V	$1D-2^3P$	
	3448.85	35	V		
	3327.88	150	III	$1D-1F$	
0.93	5610.36	(1)			
	5509.88	40	V	$1^3F'-1D'$	
	5123.21	40	V	$1^3F'-1P$	
	4065.04	(2)		$1^3F'-1F$	
	3946.22	(2)			

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Ionized Yttrium

E.P.	λ	Int.	Class	Type	Notes
1.63	7450.35	(5)		$1^3P'-1P$	
	7406.23	(2)			
	7332.96	(2)			
	6895.99	(10)		$1^3P'-1^3D'$	
	6858.22	(5)			
	6832.47	(5)			
	6795.40	(15)			
	6613.74	(20)			
	5546.03	3	V.	$1^3P'-2^3P$	
	5544.58	25	III		
	5521.61	30	II		
	5497.39	25	V		
	5480.71	8	V		
	5473.36	10	V		
	5196.44	2	V	$1^3P'-1F$	
1.73	7881.90	(5)		$2D-1P$	
	7264.14	(7)		$2D-1^3D'$	
	7193.74	(1)			
	6951.69	(3)			
	5781.68	2	V	$2D-2^3P$	
	5728.90	3n	V		
	5402.77	20	V	$2D-1F$	

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Neutral Yttrium I.P. 5?

E.P.	λ	Int.	Class	Type	Notes
0.0	4235.94	100	II		
	4142.88	200	II	$1D^2 - 2D'^2$	
	4128.35	300	II		
	4039.84	60	II		
	4174.18	100	II		
	4083.72	100	II	$1D^2 - 1P^2$	
	4047.66	80	II		
	4167.57	100	II		
	4102.42	350	II	$1D^2 - 2F^2$	
	4077.39	300	II		
	3620.95	400	II		
	3592.90	200	II	$1D^2 - 2P^2$	
	3552.70	40	I		
	3512.88	20	III	$(1D^2 - 1G'^4)$	
	3484.05	10	III		
	3209.38	(1)			
	3185.93	2	IIIA	$(1D^2 - 1F^4)$	
	3172.85	4	IIIA		
	3155.62	3	IIIA		
	3045.36	20	II		
	3021.70	15	II	$(1D^2 - 1D'^4)$	
	3005.24	12	III		
	2996.93	20	III		
	3022.27	12	II		
	2984.26	50	II	$1D^2 - 3F^2$	
	2974.58	35	II		
	2995.25	10	III		
	2964.96	30	II	$1D^2 - 3D'^2$	
	2948.39	30	II		
	2919.06	20	II		

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Neutral Yttrium I.P. 5?

E.P.	λ	Int.	Class	Type	Notes
1.38	5740.23	(1)			
	5675.26	(3)			
	5644.68	(4)			
	5630.12	(8)		$1F'^4 - 1G'^4$	
	5606.32	(3)			
	5581.86	(8)			
	5527.53	(10)			
	5466.46	(10)			
	4906.10	(3)			
	4900.11	(10)			
	4893.44	(3)			
	4859.83	(8)			
	4852.69	(8)		$1F'^4 - 1F^4$	
	4845.68	(8)			
	4839.86	(10)			
	4819.64	(3)			
	4799.31	(4)			
	4781.04	(3)			
	4527.79	(8)			
	4527.26	(8)			
	4505.95	(8)			
	4487.48	(6)		$1F'^4 - 1D'^4$	
	4487.29	(3)			
	4477.41	(4)			
	4475.71	(4)			
	4458.95	(2)			
	4436.14	(1)			

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Neutral Yttrium I. P. 5?

I P Cont	λ	Int	Class	Type	Notes
1.38	4476.92	25	III		
	4443.66	15	III		
	4437.32	10	III	$(1F'^4 - 3F^2)$	
	4409.71	(1)			
	4394.03	3	III		
	4379.33	6	III	$(1F'^4 - 3D'^2)$	
	4352.34	5	III		
	4314.92	(1)			
	7550.				
	7478.				
	7438.			$1F'^4 - 2F^2$	
	7361.				
	7339.				
	7233.				

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Ionized Lanthanum

La +

λ I.A	Int	Class	Type	
2796.37	+	~~II~~		
2798.65	1	V E		
2808.36	10	V E		
2815.34				
2848.34				
2855.89	1	V E		
2859.73				
2862.95	1	V E		
2880.63	3	V E		
2885.14	4	V E		
2893.08	4	V E		
2950.51	2	V E		
3104.598	60	IV E	—	$a^1D - b_3$
3108.463	5	IV E		$a^1D - a^3P_1$
3142.766	50	IV E		$a^3F'_2 - a^3P_2$
3171.66	-	V E		$^2S_1 - {}^2P_2$
3179.344				
3193.019	15? 10?	IV E IV E		
3245.130	200	III E		$a^3F'_2 - b_3$
3249.365	100	III E		$a^3F'_2 - a^3P_1$
3265.671	150	III E		$a^3D_2 - a^3P_2$
3303.113	200	III E		$a^3D_1 - a^3P_1$
3306.988	10	IV E		$a^3F'_4 - b_3$
3337.481	500	III E		$a^3D_3 - a^3P_2$
3344.551	300	III E		$a^3D_1 - a^3P_0$
3376.316	40	III E		$a^3D_2 - b_3$
3380.888	400	III E		$a^3D_2 - a^3P_1$
3397.748	4	V E		
3452.220	50	III E		
3453.178	70	III E		$a^3D_3 - b_3$

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Ionized Lanthanum cont

La +

λ	Int	Class	Type
3509.995	25	IV E	$a^3F'_3 - I_2$
3512.926	25	IV E	
3517.12	–	V E	$^2S_1 - {}^2P_1$
3530.664	20	V ? E	$a'D - a^3D'_3$
3550.822	15	IV ? E	$a'D - II_1$
3557.257	20	IV ? E	$a^3F'_2 - I_2$
3581.855			
3593.303	2	V E	
3601.060	15	V E	
3612.359	8	V E	
3621.755	4	V E	$a^3D_1 - I_2$
3628.841	125	IV E	$a^3F'_3 - a^3F_4$
3637.165	50	IV E	$a^3P'_1 - a^3P_2$
3645.423	400	IV E	$a'D - a'P$
3650.189	125	IV E	$a'D - a^3D'_2$
3662.083	50	IV E	$a^3F'_3 - a^3D'_3$
3701.809	4	V E	
3705.831	125	V E	$a^3P'_2 - a^3P_2$
3713.558	300	IV E	$a^3F'_2 - a^3D'_3$
3714.876	160	V E	$a^3P'_0 - a^3P_1$
3715.537	80	IV E	$a^3D_2 - I_2$
3725.060	40	IV E	$a'D - a^3F_3$
3735.847	20	IV E	$a^3F'_2 - II_1$
3759.089	600	III E	$a^3F'_4 - a^3F_4$
3780.686	50	V E	$a^3P'_1 - a^3P_1$
3784.808	20	V E	$a'D - a^3F_2$
3790.831	600	III E	$a^3F'_3 - a^3D'_2$
3794.781	600	III E	$a^3F'_4 - a^3D'_3$
3808.75	*		$a^3D_3 - I_2$
3835.10	20	V E	$a^3P'_1 - a^3P_0$

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Ionized Lanthanum cont

La +

λ	Int	Class	Type
3840.696	50	V? E	$a^3F'_2 - a'P$
3846.02	20	V? E	$a^3F'_2 - a^3D'_2$
3849.035	200	III? E	$a'D - a^3D'_1$
3854.96			$a^3P'_2 - a^3P_1$
3871.632	300	III? E	$a^3F'_3 - a^3F_3$
3886.326	400	III E	$a^3D_2 - a^3D'_3$
3910.818	15	IV? E	$a^3D_2 - II_1$
3916.048	400	III E	$a^3D_1 - a'P$
3921.547	300	III E	$a^3D_1 - a^3D'_2$
3929.24	500	III E	$a^3F'_2 - a^3F_3$
3936.227	60	IV E	$a^3F'_3 - a^3F_2$
3949.103	1000	III E	$a^3D_3 - a^3F_4$
3988.526	800	III E	$a^3D_3 - a^3D'_3$
3995.767	600	III E	$a^3F'_2 - a^3F_2$
4023.587	15	IV E	
4025.891	40	IV E	$a^3D_2 - a'P$
4031.701	300	III E	$a^3D_2 - a^3D'_2$
4036.602	8	V E	
4042.920	300	IV E	$a^3F'_4 - g_1$ $a'G_4 - 6'F_3$
4050.093	60	V E	
4067.398	125	IV E	$a^3F'_2 - a^3D'_1$
4076.704	30	IV E	$a'D - VI_3$
4077.338	400	III E	$a^3D_1 - a^3F^2$
4086.718	400	III E	$a'D - b'D'$
4099.544	60	V E	
4123.228	600	III E	$a^3D_2 - a^3F_3$
4141.718	80? 40?	IV E	$a^3D_3 - a^3D'_2$
4151.951	300	III E	$a^3D_1 - a^3D'_1$?
4152.758	40	IV? E	
4192.352	80	V E	

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Ionized Lanthanum Cont

La +

λ	Int.	Class	Type	
4196.555	300	III E	$a^3D_2 - a^3F_2$	
4204.038	100	V E	$a^3P_1' - I_2$	
4217.558	80	V E		
4230.966	30	V E		
4238.402	400	III E	$a^3D_3 - a^3F_3$	
4250.015	25	V E		
4263.599	100	V E	$a^3D_3 - 3_4$	$a^3F_3' - a^1D_2'$
4269.508	150	V E		
4275.651	60	IV E	$a^3D^2 - a^3D_1'$?	
4296.985	150	V E		
4296.058	200	IV E	$a^3P_2' - I_2$	—
4300.450	30	IV E	$a^1D - m^3D_3'$	
4315.909	12	V E	$a^3D_3 - a^3F_2$	
4322.514	150	III E	$a^3F_2' - VI_3$	
4333.774	600	III E	$a^3F_2' - b'D'$	
4334.976	60	V E		
4337.79				
4354.411	80	IV E		
4363.078	4	V E		
4364.687	30	IV E	$a^3P_0' - II_1$	
4378.174	15	IV E		
4383.46	25	V E		
4385.224	20	V E		
4411.226	2	V E		
4419.169	6	V E		
4427.590	40	V E		
4429.905	500	III E	$a^3D_1 - b^3D'$	
4432.961	?	Ind. but coincides with band head	$a^3F_4' - VI_3$	
4435.853	6	IV E	$a^1D - a_3$	
4455.822	25	V E	$a^3P_1' - II_1$	

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Ionized Lanthanum Cont

La +

λ	Int	Class	Type
4522.386	500	III E	$a^1D - a^1D'$
4525.315	20	V E	
4526.122	200	III E	$a^3P_2' - a^3D_3'$
4530.589	2	V E	
4558.480	250	III E	$a^3D_2 - VI_3$
4559.297	50	V E	$a^3P_2' - II.$
4570.974	8	V E	$a^3D_2 - b^1D'$
4574.903	300	III E	$a^3F_2' - m^3D_3'$
4580.079	100	V E	
4605.789	50	V E	$a^3P_1' - a^1P_2'$
4613.407	200	V E	$a^3P_1' - a^3D_2'$
4619.886	150	V E	
4636.430	4	V E	
4643.13	5		
4645.315	40	V E	$a^3F_3' - u_3$
4647.500	8	V E	
4653.542	150	V E	
4662.547	200	III E	$a^1D - m^3D_1'$
4663.801	50	V E	
4668.926	50	V E	
4671.834	40	V E	
4688.65	2	V E	
4691.171	30	V E	
4692.508	60	V E	
4699.623	20	V E	$a^3D_3 - VI_3$
4703.273	20	V E	
4712.907	1r	V E	$a^3D_3 - b^1D'$
4716.418	25	V E	$a^3P_2' - a^1P$
4717.566	4	V E	$a^3F_3' - W_2?$
4719.904	15	V E	

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Ionized Lanthanum Cont La+

λ	Int	Class	Type
4724.387	6	V E	$a^3P'_2 - a^3D'_2$
4728.378	80	V? E	$a^3F'_2 - w_3$
4739.780	2	V E	
4740.257	150	III E	$a^3F'_3 - a'D'$
4743.073	100	V E	
4748.714	100	V E	
4794.565	2	V E	
4796.680	4	V E	
4804.035	50	V E	
4809.000	80	V E	
4824.039	80	III E	$a^3P'_0 - a^3D'_1$
4826.850	1	V E	$a^3F'_2 - a'D'$
4830.501	1	V E	$a^3P'_1 - a^3F_2$
4840.000	10	V E	$a^3D_2 - m^3D'_3$
4850.559	5	V E	$a^3P'_2 - a^3F_3$
4860.883	100	III E	$a^3F'_4 - w_3$
4899.908	300	III E	$a'D \quad x_3$
4920.954	400	III E	$a^3F'_3 - x_4$
4921.778	400	III E	$a^3D_1 - y_2$?
4934.825	20	V E	
4935.599	2	V E	$a^3P'_1 - a^3D'_1$
4946.428	20	IV? E	$a^3D_1 - a'D'$
4952.038	5	V E	
4970.378	100	III E	$a'D_2 - a'F_3$?
4986.816	100	III E	$a^3F'_2 - m^3D'_1$
4991.262	20	IV E	
4996.799	2	V E	
4999.466	200	III E	$a^3D_3 - m^3D'_3$
5002.107	3	V E	
5048.006	1	V E	

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Ionized Lanthanum Cont La +

λ	Int.	Class	Type
5062.892	4	V E	$a^3P_2' - a^3D_1'$
5080.209	1	V E	
5090.563	tr	V E	
5114.565	150	III? E	$a^3D_1 - m^3D_1'$
5122.992	150	III E	$a^3D_2 - a'D'$
5156.743	30	V E	$a^3F_3' - x_3$
5157.445	15	V E	
5163.619	20	V? E	$a^3F_4' - x_4$
5172.898	1	V E	
5173.849	10	IV? E	
5183.419	400	III E	$a^3D_2 - w_3$
5188.210	25	V E	$a^3F_3' - w_4$
5204.156	12	V E	
5226.201	1	V E	
5259.383	40	III E	$a^3F_2' - x_3$
5279.135	2	V E	??
5290.841	60	III E	
5301.988	200	III E	$a^3D_3 - a'D'$
5302.641	40	V E	
5303.555	100	III E	$a^3D_2 - m^3D_1'$
5340.698	40	III E	$a^3F_2' - a'F$??
5377.099	2	V E	
5380.994	80	V E	
5381.911	15	V E	
5458.673	20	V E	$a^3F_4' - w_4$
5464.366	25	V E	$a^3P_2' - VI_3$
5480.715	1	V E	
5482.264	50	V E	$a'D - y_2$
5493.452	20	V E	
5535.677	15	V E	$a^3D_3 - a'F_3'$??

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Ionized Lanthanum Cont

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	λ	Int.	Class	Type
	~~5535.677~~	~~15~~	~~V E~~	
	5566.924	2		??
	5671.541	8	V E	
	5703.29	10	III	are ??
	5712.398	20	III E?	
	5727.269	4	V E	
Kiess	5769.07	50?	V E	
Kiess	5797.59	50	III E	
"	5805.77	50	III E	$a^3F_3' \; y_2$
	5808.29	10	IV?	
"	5863.68	20	V E	
	5873.988	3	IV	$a^3P_2' - m^3D_3'$
"	5880.62	30	III E?	
	5892.66	1	V	
"	5901.96	2	IV E	
"	5927.66			
"	5936.22	12	V E	$a^3F_2' - y_2$
"	5973.51	5	V E	
	6067.15		IV?	asc?
	6100.47			$a^3P_1' - a^1D'$
	6129.55	15	IV?	
	6146.55	5	IV	
	6172.73	5	V	
	6174.19	1	V	
	6262.30	80?	III	
Kiess	6296.10	50	IV E	$a^3P_2' - a^1D_2'$
"	6310.94	4	V E ??	
com by King	6358.24			$a^3P_1' - m^3D_1'$
	6390.45	80	III	
Kiess	6399.06	10	V ? E	

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Ionized Lanthanum 6. La +

	λ	Int	Class	Type
Kiess	6446.62	5	V E	
	6498.19	7	IV ? E	
	6526.98	100	III E	
	6570.94		III	
	6642.78		V E	
	6671.40		IV ? E	
	6714.09		V E	
	6718.66		V E	
	6732.79		V E	
	6774.27		III E	
	6813.66		V ? E	
King	6830.82		V E	
	6834.06		IV ? E	
	6837.91		IV ? E	$a^3D_2 - a^3F_2$
	6958.09		IV E	$6'D_2 - a'D'_2$
King	6968.72		V E	
	7066.19		III E	
	7282.32		III E	
	7483.45		IV E	

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Unusual

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Enhanced Iron. Fe +

163-164' ✓	Merrill	PASP 36, 225, 1924	The iron star HD 161114
? ✓	Merrill	PASP 35, 263, 1923	Two stars of class F having the
? ✓	Joy	PASP 36, 349, 1924	Hα line bright
	Adams, Joy, Humason	PASP 34, 175, 1922	Spectroscopic observations of R Scuti The Wave lengths of certain bright lines in the spectra of some M type stars (B020 5650, W Cep, HD 42474)
	Sanford	PASP 32, 349, 1920	The spectrum of T Tauri
	Humason	PASP 34, 258, 1922	Discovery of bright hydrogen lines in the spectrum of the variable star W Cephei
	Adams, Joy, Humason	PASP 37, 159, 1925	An additional star of the W Cephei type of spectrum
	Adams, Joy	PASP 37, 160, 1925	Additional stars with Cepheid characteristics of spectrum

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