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**A Spectrographic Study of Early
Class B Stars**

Third Paper

BY

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A SPECTROGRAPHIC STUDY OF EARLY CLASS B STARS

THIRD PAPER

BY F. HENROTEAU, PH.D.

The present paper, in which Mr. J. F. Frédette greatly assisted, is the third of a series, and continues the work begun on class B stars and published as Vol. V, Nos. 1 and 3 of the Publications of the Dominion Observatory, Ottawa.

As before, a table of the stars investigated, arranged in order of right ascension, is given, and each star is considered separately.

THIRD SERIES

H.R.	Star	R. A. (1900)		Decl. (1900)		Visual Mag.	Spect.
		h	m	°	'		
1044	34 Persei.....	3	22.2	+49	10	4.67	B3
1220	ε Persei.....	3	51.1	+39	43	2.96	B
1765	22 Orionis.....	5	16.7	- 0	29	4.65	B3
1931	σ Orionis.....	5	33.7	- 2	39	3.78	B
1934	ω Orionis.....	5	33.9	+ 4	4	4.54	B3
1948	ζ Orionis.....	5	35.7	- 2	0	2.05	B
2004	κ Orionis.....	5	43.0	- 9	42	2.20	B
2344	10 Monocerotis.....	6	23.0	- 4	42	4.98	B3
2490	42 Camelopardalis.....	6	40.5	+67	41	5.04	B3
2648	19 Monocerotis.....	6	57.9	- 4	6	4.89	B3
3192	16 Puppis.....	8	4.5	-18	57	4.34	B3
3453	η Hydrae.....	8	38.0	+ 3	46	4.32	B3
6453	θ Ophiuchi.....	17	15.9	-24	54	3.37	B3
6588	ι Herculis.....	17	36.6	+46	4	3.79	B3
6712	66 Ophiuchi.....	17	55.3	+ 4	23	4.81	B3
6787	102 Herculis.....	18	4.4	+20	48	4.32	B2
7298	η Lyrae.....	19	10.4	+38	58	4.46	B3
7306	1 Vulpeculae.....	19	11.9	+21	13	4.60	B5
7372	2 Cygni.....	19	20.2	+29	26	4.86	B2
7426	8 Cygni.....	19	28.1	+34	14	4.85	B3
7447	ι Aquilae.....	19	31.6	- 1	31	4.28	B5
7688	17 Vulpeculae.....	20	2.5	+23	19	5.08	B3
7739	H. R. 7739.....	20	11.0	+25	17	4.82	B3
7852	ε Delphini.....	20	28.4	+10	58	3.98	B5
7977	55 Cygni.....	20	45.5	+45	45	4.89	B2
8146	66 Cygni.....	21	13.8	+34	29	4.42	B3p
8279	9 Cephei.....	21	35.2	+61	38	4.87	B2
8356	16 Pegasi.....	21	48.5	+25	27	5.05	B3
8762	1 Andromedae.....	22	57.3	+41	47	3.63	B3
8773	β Piscium.....	22	58.8	+ 3	17	4.58	B5
8858	ψ ² Aquarii.....	23	12.7	- 9	44	4.56	B5

We shall now consider these stars separately.

34 PERSEI

The spectrum of 34 Persei is very poor and difficult to measure. The following are our results using a measuring microscope of very small magnification.

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 34 PERSEI

Element	λ	Width, angstroms	9480		9481		9482		9483		9484		9485	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He	4243.928	.....					-66.9	1						
C	4267.301	.....					-57.8	1	+36.4	1				
H γ	4340.634	4.3.....	+56.5	1	-22.6	2	+67.8	1	+84.7	1	-88.1	1	+55.4	1
He	4388.100	very diffuse			-10.5	1	-3.5	5	+46.8	3			+101.8	1
He	4471.676	4.5.....	+16.1	4	-31.0	6	-9.9	4	-6.2	7	-42.2	5		
Mg	4481.397	.....					-3.8	2	-22.5	2	-42.5	2		
H β	4861.527	6.0 diffuse.			+12.7		+35.0	1	+19.1	1	+22.3	1		

The measures of the last plate are altogether unreliable. From the others we have the following velocities, corrected for the Earth's motion.

Plate	Date	Velocity
		km.
9480	1921 Jan. 28.574.....	-0.3
9481	.545.....	-47.8
9482	.582.....	-30.7
9483	.619.....	-12.1
9484	.655.....	-65.2

A velocity has been given also by Adams at the Mt. Wilson Observatory*; it is -1.6 km. He does not give any date.

In spite of the great discordances in the measures of the lines it would be well to secure a number of good spectrograms of 34 Persei, as it may possibly have a very short-period variation of radial velocity.

 ϵ PERSEI

The spectra of ϵ Persei are very poor. According to Frost and Adams† there is a considerable difference in the appearance of the same lines on the different one-prism spectrograms they had secured. They consider, however, that the radial velocity of ϵ Persei is variable.

We have obtained six spectrograms of ϵ Persei, but the lines being very diffuse, the velocities furnished by the different lines do not accord at all well with each other.

We shall only give here the list of published velocities together with our own.

* Ap. J., Vol. 42, 1915, p. 176.

† Ap. J., Vol. 19, 1904, p. 152.

RADIAL VELOCITIES OF ϵ PERSEI

Place	Plate	Date	Velocity	Number of lines measured
Yerkes.....		1903 Nov. 7.819.....	km. - 4	
		17.567.....	-28	
		Dec. 1.639.....	-24	
		26.794.....	unreliable	
		1904 Jan. 23.641.....	unreliable	
		1907 Sept. 23.767.....	-22	
		24.897.....	+13	
Ottawa.....	8803	Oct. 7.940.....	unreliable	
		1919 Nov. 13.870.....	+26.4 \pm 5.0	5
	8805	.897.....	- 4.3 \pm 8.6	5
	8806	.914.....	+ 7.5 \pm 5.5	6
	8807	.925.....	+ 7.4 \pm 4.8	7
	(1) 8808	14.654.....	-21.2 \pm 9.4	3
	(2) 8808	.664.....	+11.3 \pm 2.4	5

22 ORIONIS

The spectrum of 22 or σ Orionis is rather good for an early class B star. It is susceptible of fairly accurate measurement, and does not indicate a very large variation of radial velocity. 22 Orionis was announced to be a spectroscopic binary by Frost and Adams*; the range of velocity they found to be only 14 kilometers.

The detailed measures of the plates which we have taken of 22 Orionis are given in the following table:—

LINES, THEIR WIDTHS AND VELOCITIES, IN SPECTRA OF 22 ORIONIS

Element	λ	Width, angstroms	9487		9488		9489		9490		9491	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He	4026.352	0.5							+49.6	1		
H δ	4101.890	1.7							+66.0	1		
He	4121.016				+32.3	1						
He	4143.928	1.1			+46.6	2	+49.5	1	+60.1	1	+19.4	1
C	4267.301	0.7			+42.8	4			+63.1	7		
H γ	4340.634	1.7	+56.5	1	+68.9	3	+64.4	3	+44.1	4	+35.0	1
He	4388.100	1.2	+52.7	4	+43.3	8	+46.8	7	+56.2	3	+53.8	4
He	4471.676	0.8	+58.3	3	+50.8	3	+43.4	5	+45.9	8	+31.0	4
Mg	4481.397				+52.5	1						
Si	4552.636						+72.0	1				
Si	4567.897										+58.5	1
Si	4574.791										+89.1	1
He	4713.308		+74.5	1								
H β	4861.527	2.5					+65.2	1	+49.3	2		

* Ap. J., Vol. 18, 1903, p. 385.

The radial velocities published by other observatories, as well as those obtained from the above measures, are:—

RADIAL VELOCITIES OF 22 ORIONIS

Place	Plate	Date	Velocity
			km.
Yerkes.....	.....	1903 Feb. 19-666.....	+31
		25-565.....	+29
		Mar. 6-600.....	+31
		Sept. 5-911.....	+19
		18-907.....	+32
		26-914.....	+27
		Oct. 10-857.....	+32
		17-950.....	+27
		24-836.....	+33
Ottawa.....	9487	1921 Feb. 1-565.....	+34.7 ± 2.4
	9488	3-555.....	+24.6 ± 2.6
	9489	-591.....	+28.0 ± 2.8
	9490	-638.....	+29.5 ± 2.0
	9491	-679.....	+21.6 ± 5.5

These velocities seem to indicate that 22 Orionis is a short-period binary, but on account of the small range of velocity a fairly large number of spectrograms of this star should be secured.

σ ORIONIS

σ Orionis was announced to be a spectroscopic binary by Frost and Adams*. The lines we find in our spectra are diffuse, but our measures indicate a rather large and very rapid variation of velocity. It is thus quite possible that the star may be of the β Canis Majoris type.

The detailed measures for our spectra are given in the following table:—

LINES, THEIR VELOCITIES AND WIDTHS IN SPECTRA OF σ ORIONIS

Element	λ	Width, angstroms	8818		8819		8820		8822 (1)		8822 (2)		8823	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He	4026.352	1.2 very diffuse...	-5.2	1	+11.3	1	-20.9	1	+19.1	1	+0.9	1	-56.6	1
Hδ	4101.890	2.3 "	-26.0	1	+10.2	1	.....	.....	-4.6	1	+5.6	1	+13.0	2
He	4143.928	0.8 diffuse.....	-11.6	1	.....	.....	.....	.....	+2.9	2	+9.7	2	-1.9	1
C	4267.301	.....	-39.6	2	.....	.....	.....	.....	+40.7	4	+1.1	2	.....	.....
Hγ	4340.634	2.5 very diffuse...	-17.0	2	+18.1	2	-27.1	2	+21.5	4	+2.3	4	+7.9	2
He	4388.100	1.7 "	-46.8	2	.....	.....	.....	.....	-22.2	2	+11.7	2	+45.6	3
He	4471.676	2.1 "	-48.4	3	+34.7	4	+38.4	5	-21.1	4	-39.7	4	+2.5	3
C	4650.925	2.4 " .....	.....	.....	.....	.....	+37.8	5	.....	.....	.....	.....	.....	.....
H	4685.970	2.3 " .....	.....	.....	.....	.....	+2.9	4	.....	.....	.....	.....	.....	.....
Hβ	4861.527	5.7 "	-11.1	1	+30.2	1	+23.8	1	+46.1	1	+50.9	1	-8.0	2

* Ap. J., Vol. 19, 1904, p. 153.

The above measures, together with the velocities published formerly, give us the following table:—

RADIAL VELOCITIES OF σ ORIONIS

Place	Plate	Date	Velocity
			km.
Yerkes.....		1903 Dec. 1.872	+18
		25.853	+35
		1904 Jan. 2.760	+14
Ottawa.....	8818	1919 Nov. 30.722	-24.8 \pm 4.1
	8819	.778	+31.5 \pm 3.4
	8820	.794	+25.2 \pm 7.3
	8822 (1)	.828	+15.9 \pm 6.4
	8822 (2)	.840	+ 3.3 \pm 6.0
	8823	.892	+14.0 \pm 7.1

ω ORIONIS

ω Orionis was announced to be a spectroscopic binary in Campbell's second catalogue of spectroscopic binaries (unpublished letter from the Yerkes Observatory). The lines in its spectrum are rather wide and diffuse, the helium lines, however, being much more diffuse than the hydrogen lines. On plate 9477 weak second components of the different lines are suspected to exist, while on both plates a rather weak emission line is certainly present in the middle of the absorption line at $H\beta$. Merrill had already mentioned the fact that $H\gamma$ was a strong emission line, while $H\beta$ was a well-defined double bright line on absorption. On our spectrograms bright $H\beta$ is certainly single and weak.

The following are the detailed measures of our plates:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF ω ORIONIS

Element	λ	Width of absorption line, angstroms	9476		9477	
			Vel.	Wt.	Vel.	Wt.
$H\delta$	4101.890	4.0	+14.9	2	+40.9	1
He	4143.928	3.8	+40.7	4	.....	.....
$H\gamma$	4340.634	3.7	+33.9	4	+54.2	4
He	4388.100	4.1	.....	.....	+43.3	3
He	4471.676	5.7	+52.0	4	+31.0	5
Mg	4481.397	.....	.....	.....	+ 8.8	1
$H\beta$	4861.527	4.4	+31.8	3	+62.0	3

This gives for the radial velocities of ω Orionis

Plate	Date	Velocity
		km.
9476	1921 Jan. 25.559	+17.9
9477	.596	+24.0

We did not secure any more plates of ω Orionis, the spectrum being rather poor. It would, however, be an interesting star to investigate.

ζ ORIONIS

This is one of the twenty stars investigated by Frost and Adams (Radial Velocities of Twenty Stars having Spectra of the Orion Type).^{*} According to them the spectrum (obtained with three prisms) is extremely difficult of measurement, the lines being few in number and extremely broad and ill-defined. On our one-prism spectrograms we also find a few lines, but although broad they have sharp edges and are susceptible, with a microscope of rather low magnification, of being centered with accuracy. Our detailed measures, which follow, agree very well with one another.

Element	λ	Width, angstroms	8812 (1)		8812 (2)	
			Vel.	Wt.	Vel.	Wt.
<i>Si</i>	4089·090	.....	-23·0	1	- 1·8	1
<i>Hδ</i>	4101·890	3·4	+ 4·6	1	.....	.....
<i>Si</i>	4116·510	.....	.....	.....	- 9·4	1
<i>Hγ</i>	4340·634	3·8	- 5·6	2	- 6·8	4
<i>He</i>	4471·676	3·9	- 8·7	2	-17·4	5
<i>Hβ</i>	4861·527	6·2	-30·2	1	.....	.....

These velocities, together with those published formerly, give us the following table:—

RADIAL VELOCITIES OF ζ ORIONIS

Place	Plate	Date	Velocity	Remarks
Potsdam.....		1888 Dec. 28·360.....	km. +15·9	Vogel's Velocities.
		1889 Jan. 4·387.....	+18·3	
		1888 Dec. 28·360.....	+ 3·7	Scheiner's Velocities.
		1889 Jan. 4·387.....	+21·5	
		1901 Oct. 3·862.....	+17·4	
Yerkes*.....		1902 Oct. 23·989.....	+15·3	
		29·795.....	+18·2	
		.823.....	+16·9	
		30·818.....	+21·2	
Ottawa.....	8812 (1)	1919 Nov. 14·851.....	+2·1	
	8812 (2)	.856.....	+1·7	

The star is most likely a spectroscopic binary and ought to be investigated as such.

* Pub. Yerkes Obs., Vol. 2, 1903, p. 210.

κ ORIONIS

This is one of the stars investigated by Frost and Adams in their paper "Radial Velocities of Twenty Stars having Spectra of the Orion Type."* Our spectrograms show very wide lines whose edges, however, are fairly well defined; these lines, as can be seen from the following detailed measures, give velocities that agree with one another very well for such a type of spectrum.

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF κ ORIONIS

Element	λ	Width, angstroms	8842		8843 (1)		8843 (2)		8844 (1)		8844 (2)		8845	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He	4026.352	.....	+13.0	1	+20.0	1	- 3.5	1	+24.4	1	-14.8	1	.....	.....
O	4076.080	3.2	+12.0	6	+17.5	1	+12.9	1	+ 7.4	2	+12.9	2	-13.8	1
Hδ	4101.890	4.4	.....	.....	- 0.9	1	- 4.6	1	.....	.....	.....	.....	+17.7	1
Si	4116.510	2.9	.....	.....	-15.0	1	- 3.8	1	.....	.....	+13.2	1	.....	.....
He	4143.928	.....	.....	.....	.....	.....	+ 5.8	1	+26.2	1	+ 7.8	1	+ 1.9	1
Hγ	4340.634	5.0	- 9.0	5	- 4.5	1	- 1.1	1	- 1.1	4	.....	.....	+30.5	2
He	4388.100	3.5	.....	.....	.....	.....	+ 4.7	1	.....	.....	.....	.....	+ 3.5	1
He	4471.676	4.3	- 6.2	4	+26.0	1	+26.0	1	+ 8.7	4	+13.6	2	+13.6	4
Si	4552.636	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+22.3	1
O	4649.250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+21.0	1
He	4713.308	.....	.....	.....	.....	.....	+11.7	1	.....	.....	.....	.....	+55.5	1
Hβ	4861.527	7.0	+ 1.6	1	+25.4	1	+ 9.5	1	+41.3	1	+22.3	1	+27.0	1

These together give, with the radial velocities published formerly, the following table:—

RADIAL VELOCITIES OF κ ORIONIS

Place	Plate	Date	Velocity
Yerkes	.....	1901 Sept. 20.926	+14.9
		26.893	+20.6
		Oct. 17.809	+20.3
		23.810	+18.8
		31.850	+19.8
		1902 Mar. 13.603	+20.8
		April 9.575	+19.0
Ottawa	8842	1919 Dec. 10.743	+ 3.7 ± 3.2
	8843 (1)	.761	+12.4 ± 4.1
	8843 (2)	.769	+ 8.4 ± 2.0
	8844 (1)	.790	+13.1 ± 3.8
	8844 (2)	.800	+12.8 ± 3.0
	8845	.851	+20.4 ± 3.5

A rapid change of velocity is doubtful, considering the large widths of the spectral lines.

* Pub. Yerkes Obs., Vol. 2, 1903, p. 213.

10 MONOCEROTIS

Although 10 Monocerotis does not have in its spectrum lines of the very best, and notwithstanding the fact that very few plates have been secured, there seems to be no doubt that it is a very short period binary, probably of the β Canis Majoris type. The following detailed measures have been obtained:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 10 MONOCEROTIS

Element	λ	Width, angstroms; plate 9495	9492		9494		9495	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He	4121.016	.....	+11.4	1	.....	.....	.....	.....
He	4143.928	1.9	.....	.....	.....	.....	+26.2	1
H γ	4340.634	6.5	0.0	1	+66.7	2	- 3.4	1
He	4388.100	3.8	+33.9	1	+66.7	1	+17.6	2
He	4471.676	3.3	+24.8	4	+48.4	3	+18.6	3
Mg	4481.397	2.7	.....	.....	.....	.....	+62.5	3
He	4713.308	4.6	.....	.....	+77.4	1	.....	.....
H β	4861.527	10.7	+ 8.0	1	+39.8	1	.....	.....

These measures have been made by Mr. Thorn; the last two plates have also been measured by Mr. Frédette. All these measures give us the following table:—

RADIAL VELOCITIES OF 10 MONOCEROTIS

Plate	Date	Velocity by Thorn	Velocity by Frédette
9492	1921 Feb. 6-610	+ 4.1	.....
9494	8.532	+39.9	+25.9
9495	.575	+12.0	+ 9.6

To these may be added the velocity given by Dr. Campbell* in his article "On the Motions of the Brighter Class B Stars," which is

$$+ 28 \text{ km.}$$

We strongly suspect a variation of line-widths from one spectrogram to another.

42 CAMELOPARDALIS

42 Camelopardalis is a rather faint star to study with our spectrograph. However its spectrum has fairly good lines. The spectra we have obtained are weak in the continuous part, but the lines furnish velocities which agree very well with each other. Our detailed measures are given in the following table:—

* L. O. B., Vol. 6, p. 110.

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 42 CAMELOPARDALIS

Element	λ	Width, angstroms	9024		9027		9028	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
<i>Hγ</i>	4340.634	5.3	.....	.....	.....	.....	+35.0	1
<i>He</i>	4388.100	1.5	.....	.....	.....	.....	+39.8	4
<i>He</i>	4471.676	1.5	+22.3	5	+24.8	5	+29.8	2
<i>H</i>	4542.400	.....	+26.0	2	.....	.....	.....	.....
<i>Hβ</i>	4861.527	5.7	.....	.....	.....	.....	+49.3	1

This, together with the velocities obtained by Lee, gives us the following table.

RADIAL VELOCITIES OF 42 CAMELOPARDALIS

Place	Plate	Date	Velocity
			km.
Yerkes*		1903 Dec. 26.966.....	+ 3
		31.977.....	0
		1904 Jan. 23.821.....	-17
		1905 Nov. 10.947.....	+11
		1907 Jan. 25.919.....	-12
Ottawa.....	9024	1920 Mar. 23.698.....	+ 1.7 \pm 1.2
	9027	.699.....	+ 3.1
	9028	.819.....	+16.2 \pm 2.3

On the last two plates of the Yerkes Observatory Lee suspected the lines to be double. Our spectrograms do not suggest this; it is, however, very likely that 42 Camelopardalis is a short-period binary, and if it is of the β Canis Majoris type variations of line widths are to be expected.

19 MONOCEROTIS

The spectrum of 19 Monocerotis is very poor. The lines in it are exceedingly wide; their edges, however, are rather sharp, and the separate velocities given by the different lines measured with a microscope of low magnification, agree well with one another. Our detailed measures are the following:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 19 MONOCEROTIS

Element	λ	Width, angstroms	9478		9479	
			Vel.	Wt.	Vel.	Wt.
<i>Hγ</i>	4340.634	7.8 diffuse.....	.....	.....	.....	.....
<i>He</i>	4388.100	3.5 diffuse.....	+18.7	4	.....	.....
<i>He</i>	4471.676	8.2 diffuse.....	+16.1	4	+21.1	4
<i>He</i>	4713.308	.....	.....	.....	+32.1	4
<i>Hβ</i>	4861.527	8.4 diffuse.....	.....	.....	+15.9	1

* Ap. J., Vol. 32, 1910, p. 302.

which give the following velocities:—

Plate	Date	Velocity
9478	1921 Jan. 26.572.....	km. + 8.8
9479	.....617.....	+16.7

No other velocity is known to us. The spectrum was considered to be too poor to justify further investigation.

16 PUPPIS

The lines in the spectra of 16 Puppis are very diffuse and ill defined. In some cases there is a suggestion of double lines. They furnish velocities which are far from agreeing with one another for the different lines. The following are our detailed measures:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 16 PUPPIS

Element	λ	Width, angstroms	9018		9019		9020		9021	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
<i>Hδ</i>	4101.890	5.6.....	+ 44.6	1	.....	.....	- 14.0	1	.....	.....
<i>He</i>	4143.928	3.3 very diffuse...	+ 20.4	1	.....	.....	- 16.5	1	.....	.....
<i>O</i>	4153.850	.....	.....	.....	.....	.....	- 47.5	2	.....	.....
<i>C</i>	4267.301	.....	.....	.....	.....	.....	.....	.....	+63.1	3
<i>O</i>	4327.610	3.3 very diffuse...	- 11.2	1	.....	.....	.....	.....	.....	.....
<i>Hγ</i>	4340.634	4.5.....	+ 12.4	3	.....	.....	+ 72.3	1	0.0	2
<i>He</i>	4388.100	4.0.....	+ 85.4	4	+43.3	1	+ 40.9	3	+92.4	4
<i>He</i>	4471.676	4.4.....	+ 32.2	5	+79.4	6	+ 27.3	4	+26.0	3
<i>Mg</i>	4481.397	3.2.....	+ 61.2	4	+ 7.5	4	+112.5	4	+62.5	1
<i>Fe?</i>	4515.508	.....	.....	.....	.....	.....	+111.4	2	.....	.....
<i>He</i>	4713.308	very diffuse.....	+129.9	1	.....	.....	.....	.....	.....	.....
<i>Hβ</i>	4861.527	10.0.....	+ 33.4	2	.....	.....	+166.9	1	+14.3	1

These measures have been made with a microscope of the lowest possible magnification, as an ordinary measuring instrument would not have enabled us to see the lines with advantage. Large discrepancies on this account have to be expected. It is, however, remarkable how well the mean velocities given by these different plates agree with one another, as is seen in the following table.

RADIAL VELOCITIES OF 16 PUPPIS

Plate	Date	Velocity
9018	1920 Mar. 18.550.....	km. +29.2
9013	.....580.....	+32.1
9020	.....615.....	+35.6
9021	.....645.....	+32.9

No velocity has been published before for 16 Puppis.

η HYDRAE

The lines in the spectrum of η Hydrae are diffuse and necessitate the use of a microscope of fairly low magnification to measure them. η Hydrae was announced to be a spectroscopic binary by Frost and Adams.* Following are the detailed measures of two of our plates.

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF η HYDRAE

Element	λ	Width, angstroms	8896		8897	
			Vel.	Wt.	Vel.	Wt.
He.....	4143.928	3.0	-51.4	4	.....	.....
H γ	4340.634	5.1	-23.7	3	+19.2	1
He.....	4388.100	5.9	-9.4	2	+22.2	1
He.....	4471.676	5.2	-2.5	5	-12.4	8
Mg.....	4481.400	.....	.....	.....	-15.0	4
H β	4861.527	.....	-9.5	1	.....	.....

With velocities published formerly we obtain the following table:—

RADIAL VELOCITIES OF η HYDRAE

Place	Plate	Date	Velocity	Remarks
Yerkes.....	B490	1903 Feb. 4.706.....	km. + 4	Frost and Adams.
	1B214	Dec. 1.972.....	+ 6	
	225	25.973.....	+26	
Ottawa.....	8108	1917 Mar. 12.632.....	+26.0	Cannon. †
	8457	1918 Feb. 21.648.....	+33.4	
	8459	26.567.....	+22.2	
	8465	Mar. 3.686.....	+37.3	
	8483	28.593.....	+26.9	
	8491	April 4.600.....	+22.0	Henroteau.
	8852	1919 Dec. 15.901.....	+ 7.0	
	8861	16.869.....	+ 4.3	
	8896	1920 Jan. 15.762.....	-13.4	
	8897	.786.....	- 0.6	

A rather large number of spectrograms would be required in order to find out whether η Hydrae is a very short-period binary or not. Its spectrum being poor, we have abandoned its study.

θ OPHIUCHI

Only one radial velocity has been given for this star before. It is given by Dr. Campbell as being -0.9 km. ‡ Its spectrum is fairly good, as can be seen from the widths given in the following table.

* Ap. J., Vol. 19, 1904, p. 155.
 † Pub. Dom. Obs., Vol. 4, p. 254.
 ‡ L. O. B., No. 195.

θ Ophiuchi is situated in one of the most beautiful regions of the sky, where nebulosities and dark currents are abundant. It has been made the object of several of Professor Barnard's* photographs.

LINES AND THEIR WIDTHS FOUND IN THE SPECTRUM OF θ OPHIUCHI

Element	λ	Width, angstroms
He.....	4121.016	1.3
He.....	4143.928	0.7
O.....	4185.720	0.8
H γ	4340.634	2.0
He.....	4388.100	1.7
O.....	4396.140	0.2
He.....	4471.676	3.3
H β	4861.527	4.7

Only four spectrograms have been obtained here on the night of June 13, 1920. The following table gives their detailed measurements.

RADIAL VELOCITIES FROM THE DIFFERENT LINES

Element	λ	9145		9146		9147		9148	
		Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
Unknown.....	4069.700	- 4.5	2						
C.....	4267.301	-20.1	$\frac{1}{2}$						
H γ	4340.634	-14.7	1						
He.....	4388.100	- 2.3	2	- 9.4	1	+12.9	3		
O.....	4415.076	0.0	4						
He.....	4471.676	- 8.7	2	- 9.9	2	- 9.9	3	+16.1	2
Mg.....	4481.397	- 2.5	$\frac{1}{2}$			- 1.2	4		
Si.....	4552.636			-14.4	2				
He.....	4713.308			-20.3	2	-31.9	1		
H β	4861.527			-27.0	$\frac{1}{2}$			+25.4	1

These measures give us the following velocities (as usual, corrected for the rotation and revolution of the Earth).

Plate	Date	Velocity
		km.
9145	1920 June 13.683.....	- 6.2 \pm 1.6
9146	.707.....	-16.4 \pm 1.3
9147	.732.....	- 4.1 \pm 4.9
9148	.806.....	+17.5 \pm 2.8

Although the last one of these spectra is rather poor, they seem to indicate that θ Ophiuchi is possibly a star of the β Canis Majoris type. Its rather large southern declination, however, does not make it advisable to undertake its study here at Ottawa.

* Pop. Ast., Vol. 14, 1906, p. 580.

ι HERCULIS

This is one of the twenty stars studied by Frost and Adams in their article "Radial Velocities of Twenty Stars having Spectra of the Orion Type."* The spectrum of ι Herculis is good for an early class B star and susceptible of accurate measurement. The widths of most of the lines are given in the following table.

Element	λ	Width, angstroms
Hζ	3889.200	5.0 very diffuse
C	3920.800	0.5
Unknown	3926.680	0.5
K (Ca)	3933.825	0.6
He	3964.875	0.4
H and He	{ 3968.628 3970.177 }	2.9 very diffuse
He	4009.417	0.7 sharp
He	4026.352	1.4
Hδ	4101.890	1.5 diffuse
He	4121.016	0.5
Si	4128.211	0.6
He	4143.928	0.6 sharp
C	4267.301	0.8
Hγ	4340.634	2.1 very diffuse
He	4388.100	1.3 sharp
He	4471.676	1.1 sharp.
Mg	4481.397	0.8
Hβ	4861.527	4.2 diffuse
He	4922.100	3.4 diffuse

A long series of spectrograms of ι Herculis has been obtained here all through one night and furnish us the following detailed measures.

RADIAL VELOCITIES FROM THE DIFFERENT LINES

Element	λ	9041		9044		9045		9046		9047		9048		9049		9050		9051		9052		9053		
		Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	
He	3964.875																							
He	3970.177																							
He	4009.417																							
He	4026.352	-30.4	3	-30.4	4			-31.3	4	-27.8	7	-25.2	4	-27.0	4	-34.8	4	-35.7	7	-34.8	2	-35.7	5	
O	4079.110	-9.1	2																					
Hδ	4101.890	-39.1	1	-25.1	1			-27.0	3	-27.0	9	-29.8	1	-32.5	6	-41.8	6	-20.5	7	-32.5	3	-30.7	8	
He	4121.016			-47.5	3			-28.5	2	-16.2	4					-38.0	2			-19.9	4	-27.6	1	
He	4143.928	-8.7	1	-31.0	2			-31.0	7	-9.7	2	-29.1	2	-33.0	2	-30.1	4	-21.3	3	-16.5	5	-12.6	3	
C	4267.301	-28.9	1			-37.4	6	-21.4	2	-8.6	1							-20.3	5	-23.5	3	-26.8	8	
Hγ	4340.634	-26.0	4	-23.7	7	-44.1	1	-40.7	7	-28.3	7	-32.8	8	-30.5	9	-28.3	8	-33.9	8	-22.6	4	-22.6	8	
He	4388.100	-35.1	8	-48.0	3	-40.9	1	-42.1	5			-30.4	7	-48.0	3	-31.6	3	-33.9	7	-15.2	6	-30.4	7	
He	4471.676	-38.4	8	-29.8	3	-32.2	7	-29.8	7	-33.5	6	-18.6	2	-26.0	4	-16.1	6	-9.9	3	-28.5	8	-1.2	6	
Mg	4481.397	-36.3	6	-48.7	1	-38.7	2	-28.8	6											-21.3	2			
Hβ	4861.527	-6.4	1	-40.9	3	-47.7	4	-27.2	2	-19.1	3	-33.4	2	-23.9	4	-33.4	4					-30.2	3	

* Pub. Yerkes Obs., Vol. 2, 1903, p. 237.

The radial velocities published by other observatories as well as those obtained from the above measures, are:—

RADIAL VELOCITIES OF ϵ HERCULIS

Place	Plate	Date	Velocity
			km.
Yerkes	.....	1901 Sept. 27.607.....	-17.8
		Oct. 3.646.....	-16.8
		18.644.....	-15.8
		1902 Sept. 3.722.....	-16.1
Ottawa	9041	1920 April 9.615.....	-28.6 \pm 2.0
	9044	.675.....	-31.2 \pm 2.2
	9045	.700.....	-35.3 \pm 1.8
	9046	.718.....	-29.4 \pm 1.3
	9047	.757.....	-22.6 \pm 1.5
	9048	.776.....	-26.6 \pm 1.1
	9049	.795.....	-28.0 \pm 1.7
	9050	.814.....	-28.0 \pm 1.9
	9051	.831.....	-25.2 \pm 2.0
	9052	.844.....	-19.8 \pm 1.4
	9053	.854.....	-22.9 \pm 1.8

The last velocities seem to indicate a small range of less than fifteen kilometers. According to Frost and Adams the Yerkes velocities have to be corrected by +1.1 km., owing to change in wave-lengths of silicon lines. The radial velocity of the star has, no doubt, changed since 1901 and 1902; on account of the apparent small range of radial velocity variation, a fairly large number of spectrograms would be required in order to establish whether the period is very short or very long. The plotting on cross-section paper of the above Ottawa velocities make us suspect a period of about 0^d.4. If this were the case the radial velocity of the center of mass of the supposed short-period binary system would have changed since 1901.

66 OPHIUCHI

The spectra of 66 Ophiuchi are very poor; the lines are exceedingly wide and diffuse. They were measured, however, with a microscope of very small magnitude and furnished the following detailed measures:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 66 OPHIUCHI

Element	λ	Width, angstroms	9134		9135	
			Vel.	Wt.	Vel.	Wt.
H γ	4340.634	7.3	-117.5	2	.....	.....
He.....	4388.100	8.0	+ 14.0	2	-77.2	1
He.....	4471.676	8.2	- 38.4	3	-76.9	7
Mg.....	4481.397	very diffuse	.....	.....	-22.5	4

These give, corrected for rotation and revolution of the Earth, the following velocities:—

Plate	Date	Velocity
9134	1920 June 8.620.....	km. -41.1
9135	.....674.....	-54.0

This is a large velocity of approach. It suggests a rather abnormal result, unless the star should be a spectroscopic binary.

To our knowledge no radial velocity has ever been published for 66 Ophiuchi.

102 HERCULIS

102 Herculis was discovered to be a spectroscopic binary by Albrecht at the Lick Observatory.† Its spectrum is fairly good. The detailed measures of our plates are given in the following table:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 102 HERCULIS

Element	λ	Width, angstroms	9117		9118		9122		9123		9124		9125		9126	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He	4009.417	0.7	.....	.....	-17.0	½	.....	.....	-44.2	2	-26.4	2	.....	.....	-42.5	1
He	4026.352	1.9	.....	.....	.....	.....	.....	.....	-38.3	2	-53.9	5	-68.7	½	-22.6	1
Hδ	4101.890	2.6	-39.1	1	-33.5	½	-26.0	1	-20.5	1	.....	.....	.....	.....	.....	.....
		diffuse	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
He	4121.016	0.9	.....	.....	-52.6	½	-21.6	1	-15.0	4	-31.0	2	-20.7	3	.....	.....
Si	4128.211	.....	-10.4	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Si	4131.047	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	-25.6	1
He	4143.928	1.3	.....	.....	.....	.....	-27.8	3	-27.8	2	-30.7	2	-35.5	4	-47.0	1
He	4169.183	.....	.....	.....	.....	.....	-27.4	½	.....	.....	-45.1	½	.....	.....	.....	.....
C	4267.301	2.2	-27.6	2	-47.7	½	-30.7	½	-38.2	½	-30.7	1	-15.9	1	-59.4	½
		diffuse	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hγ	4340.634	2.7	-22.6	2	-31.6	½	-29.4	2	-29.4	1	-20.3	1	-47.5	2	-27.1	1
		diffuse	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
O	4367.012	.....	.....	.....	.....	.....	.....	.....	.....	.....	-32.2	½	.....	.....	.....	.....
He	4388.100	1.3	-28.1	4	-53.8	2	-12.9	2	-18.7	3	-31.6	3	-21.1	4	-55.0	2
He	4471.676	0.7	-63.2	2	-42.2	4	-22.3	3	-18.6	1	-45.9	4	-37.2	3	-36.0	2
Mg	4481.397	0.5	-12.5	5	-21.2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Si	4552.636	.....	+ 1.3	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
O	4591.066	.....	0.0	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
O	4641.886	.....	-29.2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
N	4643.244	1.0 weak	.....	.....	.....	.....	.....	.....	-63.9	½	.....	.....	.....	.....	-44.5	1
O	4649.250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	-30.6	1	.....	.....
He	4713.308	1.6	.....	.....	-21.8	4	-49.3	3	-45.0	4	- 7.2	½	-26.1	5	.....	.....
Hβ	4861.527	2.3	-12.7	½	.....	.....	-54.1	½	-19.1	1	-23.8	½	-23.8	1	-30.2	½
		diffuse	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

† L. O. B. No. 199, Vol. 6.
34015—2

This gives, with the radial velocities published by other observers, the following table:—

Place	Plate	Date	Velocity
			km.
Yerkes*	.....	1902 July 23-745.....	-11.3
		Aug. 11-674.....	-12.4
		27-625.....	-8.5
		Sept. 3-632.....	-9.2
Lick†	.....	1903 May 10-902.....	-14
		24-947.....	-13
Yerkes‡	.....	Oct. 17-571.....	-16.5
Lick	.....	1904 May 16-996.....	-15
Yerkes	.....	July 26-716.....	-16.3
Lick	.....	1907 April 12-007.....	-11
Yerkes	.....	1908 April 30-011.....	-17
		July 20-676.....	-15.6
Lick	.....	24-767.....	-16.1
		1910 May 22-871.....	-11
Ottawa**	7690	1911 June 19-883.....	-14
	7694	1916 June 6-623.....	-16.2
	9117	.....	-27.0
	9118	1920 May 20-737.....	-12.8 ± 3.4
	9122	.....	-23.4 ± 3.0
	9123	28-603.....	-20.8 ± 2.6
	9124	.....	-21.2 ± 2.6
	9125	.....	-29.1 ± 2.4
	9126	.....	-21.2 ± 2.3

There is apparently in the present case a small change of velocity in a rather short period, but a considerable number of plates would be necessary to find the exact character of the variation.

η LYRAE

η Lyrae was announced to be a spectroscopic binary by Albrecht.§ We find its spectrum fairly good and obtain from our spectrograms the following detailed measures:

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF η LYRAE

Element	λ	Width, angstroms	9129		9130		9131		9132		9133	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He	4009.417	0.8	-13.6	2	.....	.....	.....	.....	.....	.....	.....	.....
He	4026.352	0.8	-13.1	2	-17.4	1	-14.8	1	-8.7	2	.....	.....
Hδ	4101.890	1.6	-7.4	3	-29.8	2	-12.1	2	.....	.....	.....	.....
He	4121.016	0.8	-27.3	2	-12.2	3	.....	.....	-12.2	4	.....	.....
He	4143.928	0.9	-10.6	3	-20.2	5	.....	.....	+1.0	5	.....	.....
C	4267.301	1.3	.....	.....	-36.0	3	-40.3	5	-6.4	5	.....	.....
Hγ	4340.634	1.7	-11.3	6	-20.3	8	-41.8	8	-5.7	7	-55.4	3
He	4388.100	1.3	-23.4	6	-11.7	4	-16.4	6	-21.1	7	-24.6	2
He	4471.676	1.5	-13.6	8	-14.9	6	-32.2	4	-2.5	6	-40.9	3
Mg	4481.397	1.3	-17.5	2	.....	.....	-10.0	2	.....	.....	.....	.....
Hβ	4861.527	2.9	.....	.....	-12.7	2	.....	.....	.....	.....	-20.7	4

* Pub. Yerkes Obs., Vol. 2, 1903, p. 242.

† L. O. B. No. 199, Vol. 6.

‡ Ap. J., Vol. 39, 1914, p. 48.

** Jour. R.A.S.C., Vol. 11.

§ L. O. B., Vol. 5, p. 175.

This gives, with the velocities published formerly, the following results:—

RADIAL VELOCITIES OF η LYRAE

Place	Plate	Date	Velocity
			km.
Yerkes*		1902 July 31.869.....	-10.5
		Sept. 13.748.....	-10.6
		Oct. 15.591.....	- 5.3
		16.647.....	- 8.5
Lick		1906 July 11.953.....	-13.2
		1907 June 3.884.....	- 9.4
		July 24.854.....	- 9.8
Ottawa	9129	1909 June 26.931.....	- 3.2
	9130	1920 June 7.659.....	- 7.2 \pm 1.3
	9131	.692.....	-11.1 \pm 1.6
	9132	.720.....	-21.6 \pm 3.4
	9133	.772.....	- 0.5 \pm 2.0
		.822.....	-27.4 \pm 1.7

These velocities seem to indicate that a short-period variation has to be looked for and that η Lyrae is possibly a star of the β Canis Majoris type.

1 VULPECULAE

Although the lines in the spectrum of 1 Vulpeculae are rather diffuse, it is not impossible to give fairly reliable velocities. The results we have obtained seem to indicate that 1 Vulpeculae is a very short-period binary, possibly to be classified among the stars of the β Canis Majoris type. Changes in the widths of the lines from one spectrogram to another are also suspected.

Our detailed measures are as follows:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 1 VULPECULAE

Element	λ	Width	9151		9152		9198		9199		9200		9201		9202	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
H δ	4101.890	4.9									-40.0	2				
He	4143.928	1.3			-14.4	1	-16.3	1								
Fe	4179.020	1.1													-40.6	2
H	4200.500	1.2			-72.7	1									-43.4	1
Fe	4202.198		-24.2	1												
Fe	4303.420												-39.6	1		
H γ	4340.634	2.5	-50.8	2	-24.9	1	-15.8	1	-38.4	1	-27.1	2			-75.7	2
O	4367.012	0.8					-59.8	1								
N	4379.750	1.0							-42.9	3						
He	4388.100	1.7	-26.9	2			-67.9	1	-31.3	2	-29.2	1				
O	4396.140	1.4									-35.1	2				
He	4471.676	2.2	-52.1	2	-55.8	1	-22.3	1	-22.3	4	-18.6	1	-34.7	1	-75.6	4
Mg	4481.397	1.7			-13.8	1	-23.8	1			-43.8	1				
H	4542.400	1.9					-28.6	1								
Fe	4549.642														-56.3	4
Si	4552.636	0.9													-61.6	4
Si	4574.791	0.8			-82.5	1										
Fe	4584.191	2.2							-54.9	1						
N	4607.305	1.4														
O	4676.340	1.1											-62.6	1		
He	4713.308	2.5											-41.2	1		
H β	4861.527	3.9			-55.6	1			-47.7	1	-55.6	1	-40.6	3		

* Pub. Yerkes Obs., Vol. 2, 1903, p. 242.

These give us the following velocities:—

RADIAL VELOCITIES FOR 1 VULPECULAE

Plate	Date	Velocity
		km.
9151	1920 June 17·631.....	-30·7
9152	·672.....	-36·2
9198	July 22·635.....	-34·8
9199	·672.....	-38·0
9200	·710.....	-41·5
9201	·769.....	-46·0
9202	·808.....	-65·0

To these may be added the velocity given by Dr. Campbell* in his article, "On the Motions of the Brighter Class B Stars," which is

-7 km.

2 CYGNI

The lines in the spectrum of 2 Cygni are wide and diffuse. However, they are, when measured with a microscope of low magnification, susceptible of giving fairly accurate velocities, as may be seen in the following table.

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 2 CYGNI

Element	λ	Width, angstroms	9138		9139	
			Vel.	Wt.	Vel.	Wt.
<i>He</i>	4143·928	0·9	-39·4	2	.....	.....
<i>Hγ</i>	4340·634	5·1	-52·0	2	-55·4	2
<i>He</i>	4388·100	2·7	-19·9	1	+ 2·3	1
<i>He</i>	4471·676	1·5	-63·2	1	-71·9	4
<i>Mg</i>	4481·397	.....	-50·0	2	-62·5	1
<i>Hβ</i>	4861·527	.....	-30·2	1	.....	.....

These plates were also remeasured by Mr. Thorn. It is evident that the measure +2·3 for plate 9139 and line *He* 4388 is due to accidental error (perhaps dust particle on the plate while measuring), for Mr. Thorn found for that line the velocity -88·9. The velocities we have obtained are:—

Plate	Date	Velocity by Henroteau	Velocity by Thorn
		km.	km.
9138	1920 June 9·715.....	-32·4	-36·1
9139	·758.....	-45·7	-75·2

* L. O. B., Vol. 6, p. 114.

A change of velocity between the two plates is most probable. The velocity obtained before by Professor Frost at the Yerkes Observatory is -18 km.* More plates are evidently needed, but it is most likely that the star could be classified among the short-period binaries.

8 CYGNI

The spectrum of 8 Cygni is not too poor for fairly accurate measurement; the lines in it are rather narrow, although somewhat hazy. The measures of the different lines agree well with one another. Only two velocities have been given for this star before, one by Frost of -22 kilometers* and one by Campbell of -21.8 kilometers†. No dates are given for these velocities.

The radial velocities obtained here indicate that the star can be classified among the β Canis Majoris type. Spectrograms of 8 Cygni have been obtained on four nights, their detailed measures for the first night, July 15, 1920, are given in the following table:

LINES, THEIR WIDTHS AND VELOCITIES, IN SPECTRA OF 8 CYGNI

Element	λ	Width, angstroms	9183		9185		9186		9187	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He.....	4009.417	.....	-24.6	1	.....	.....	.....	.....	.....	.....
He.....	4026.352	1.6	-43.5	4	-37.4	4	-59.2	1	.....	.....
O.....	4093.150	poor	-12.9	1	.....	.....	.....	.....	.....	.....
H δ	4101.890	2.3 diffuse	-14.9	1	.....	.....	-22.3	$\frac{1}{2}$	.....	.....
He.....	4121.016	.....	.....	.....	.....	.....	-31.0	1	.....	.....
Si.....	4128.211	.....	.....	.....	.....	.....	.....	.....	-31.4	1
Si.....	4131.047	.....	.....	.....	.....	.....	.....	.....	-38.0	1
He.....	4143.928	1.0	-20.2	4	-39.4	.....	-40.3	2	.....	.....
C.....	4267.301	.....	.....	.....	-68.9	$\frac{1}{2}$	-39.2	2	-45.6	3
Unknown.....	4308.083	.....	.....	.....	.....	.....	.....	.....	-44.0	1
H γ	4340.634	2.1 diffuse	+ 9.0	1	-36.2	1	-27.1	2	-47.5	2
He.....	4388.100	1.0	-46.8	2	-25.7	5	-38.6	2	-43.3	4
He.....	4471.676	1.7	-24.8	5	-29.8	4	-40.9	3	-52.1	4
Mg.....	4481.397	1.2	-22.5	1	-38.8	1	-36.2	4	.....	.....
He.....	4713.308	0.9	0.0	2	.....	.....	-31.9	1	.....	.....
H β	4861.527	diffuse	- 4.8	1	.....	.....	-54.1	$\frac{1}{2}$	-47.7	$\frac{1}{2}$

It should be remarked that in the preceding table, in plate 9187, the lines of silicon appear and the line of carbon 4267 is well defined, while the line of magnesium 4481 is too hazy to be measured. From an examination of all the plates, it seems that when the line of magnesium appears sharp, the lines of the metalloids *Si* and *C* are rather poor and *vice versa*. Perhaps a spectral type variation occurs here, corresponding possibly to a higher or lower degree of ionization in the star's atmosphere.

* Ap. J., Vol. 32, 1910, p. 85.

† L. O. B. No. 195, Vol. 6.

The radial velocities obtained from our series of plates are:

RADIAL VELOCITIES OF 8 CYGNI

Plate	Date	Velocity	No. of lines measured
		km.	
9183	1920 July 15·623.....	-21·1 ± 3·3	11
9185	·709.....	-30·7 ± 2·2	7
9186	·757.....	-35·5 ± 1·6	11
9187	·799.....	-43·2 ± 1·3	8
9723	1921 June 23·605.....	-23·2 ± 2·0	7
9724	·664.....	-37·8 ± 2·5	5
9725	·709.....	-35·1 ± 3·0	9
9726	·753.....	-30·9 ± 3·4	12
9727	June 30·593.....	-17·0 ± 3·7	6
9728	·635.....	-26·9 ± 3·0	6
9729	·677.....	-33·5 ± 1·6	2
9730	·720.....	-42·0 ± 4·1	8
9731	July 1·592.....	-38·1 ± 2·3	9
9732	·633.....	-33·9 ± 4·0	5
9733	·675.....	-28·3 ± 8·8	2
9734	·717.....	-19·5 ± 3·4	6

ι AQUILAE

ι Aquilae was discovered to be a spectroscopic binary by Merrill at the Lick Observatory.* Its spectrum is fairly good; we have obtained three spectrograms on the same night, and there is no doubt they indicate a very rapid change of velocity.

ι Aquilae can be classified among the stars of the β Canis Majoris type. The detailed measures of our plates are given in the following table:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF ι AQUILAE

Element	λ	Width, angstroms	9169		9170		9171	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He.....	4026·352	.....	-26·1	2	-32·2	1	+11·3	½
Si.....	4089·090	.....	+ 9·2	3	.....	.....	.....	.....
Hδ.....	4101·890	2·9	.....	.....	- 6·5	2	-47·4	1
He.....	4121·016	.....	.....	.....	.....	.....	-34·8	3
Si.....	4131·047	0·7	.....	.....	.....	.....	-45·6	1
He.....	4143·928	1·1	.....	.....	- 2·9	½	.....	.....
O.....	4317·272	.....	.....	.....	-11·1	1	.....	.....
N.....	4332·620	.....	.....	.....	.....	.....	-53·8	2
Hγ.....	4340·634	2·4	-15·8	½	-41·8	2	-57·6	½
O.....	4347·580	.....	.....	.....	.....	.....	-44·1	4
O.....	4351·495	.....	.....	.....	-27·4	3	.....	.....
He.....	4388·100	0·7	.....	.....	.....	.....	-44·5	4
Fe?.....	4437·718	.....	+ 3·6	1	.....	.....	.....	.....
He.....	4471·676	0·6	.....	.....	-11·2	3	-24·8	1
Mg.....	4481·397	1·7	- 8·8	4	.....	.....	.....	.....
Hβ.....	4861·527	3·1	-28·6	½	- 1·6	½	0·0	½

* L. O. B., Vol. 6, p. 148.

This, together with other velocities published previously, gives:—

Place	Plate	Date	Velocity
			km.
Yerkes		No date	-27
Lick		1902 Aug. 25.709.....	-13
		1903 Aug. 5.821.....	-3
		1909 May 2.017.....	-25
		May 20.016.....	-22
		1910 Oct. 31.641.....	-32
		Nov. 29.566.....	-25
Ottawa	9169	1920 July 5.673.....	-4.2 ± 4.0
	9170	.711.....	-17.0 ± 3.4
	9171	.774.....	-37.7 ± 3.0

The rapid change of velocity is, no doubt, real.

17 VULPECULAE

No velocity has ever been published before for 17 Vulpeculae. The lines in its spectrum are very diffuse and difficult to measure. Our plates give the following detailed measures.

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 17 VULPECULAE

Element	λ	Width, angstroms	9179		9181		9182	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
Hγ.....	4340.634	4.1	-33.9	1	-12.4	1	.....	.....
O.....	4351.495	0.9	.....	.....	-35.0	2	.....	.....
He.....	4388.100	1.5	.....	.....	-65.5	1	-39.8	6
He.....	4471.676	2.4	-21.1	6	-39.7	2	-26.0	1
Mg.....	4481.397	1.2	.....	.....	.....	.....	-7.6	2
N.....	4614.033	2.0	.....	.....	.....	.....	-81.6	1
He.....	4713.308	1.8	+14.3	1	.....	.....	.....	.....

These give the following radial velocities:—

Plate	Date	Velocity
		km.
9179	1920 July 14.644.....	-12.2 ± 6.3
9181	.765.....	-32.1 ± 6.1
9182	.815.....	-30.3 ± 7.7

The change of velocity is doubtful.

H. R. 7739

The lines in the spectrum of H. R. 7739 have a rather peculiar appearance. They are very hazy and their edges poorly defined. Lee, at the Yerkes Observatory, seems to think that it is a binary showing two spectra*. No appearance of double lines is seen in our spectrograms; they may, however, have been taken, when the lines of the two spectra were overlapping. The following are our detailed measures, showing very little agreement and consequently unreliable velocities.

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF H. R. 7739

Element	λ	Width, angstroms	9193		9195		9197	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
<i>Hδ</i>	4101.890	6.9	- 6.5	1				
<i>Hγ</i>	4340.634	3.7	+22.6	2	+20.3	2	- 4.5	1
<i>He</i>	4388.100	3.2	+14.0	1	-79.6	2	-15.2	2
<i>He</i>	4471.676	3.7	- 1.2	4	-26.0	4	- 5.0	3
<i>Hβ</i>	4861.527	9.4	-30.2	1				

An examination of plate 9195, however, seems to show that the high velocity -79.6 for *He* 4388 is due to an accidental defect in the grain of the plate. Discarding the velocity given by plate 9195, we have for the known velocities of H.R. 7739 the following table:—

Place	Plate	Date	Velocity	Violet component	Red component
			km.		
Yerkes	IB 47	1903 June 13.817.....	-14		
		July 24.843.....	-23	-85	+30
		Sept. 5.640.....	-15	-80	+40
		18.564.....	+20	-40	+88
	372	1904 Sept. 18.846.....	-11	-58	+55
Ottawa	9193	1921 July 21.622.....	+4.5 \pm 5.2		
	9197	816.....	-3.9 \pm 2.3		

More and better spectra would be required in order to establish definitely whether the lines are single or double. In any case, a very short-period variation of radial velocity is doubtful.

 ϵ DELPHINI

The spectrum of ϵ Delphini is not very good. From comparison of velocities obtained at the Yerkes Observatory† and those obtained at the Lick Observatory, Dr. Campbell concluded that ϵ Delphini is a spectroscopic binary‡. The detailed measures of our spectrograms are given in the following table:—

* Ap. J., Vol. 39, 1914, p. 42.

† Pub. Yerkes Obs., Vol. 2, 1903, p. 246.

‡ L.O.B. Vol. 6, p. 148.

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF ϵ DELPHINI

Element	λ	Width, angstroms	9163		9164		9165		9173		9174		9175		9176	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He	4009.417	1.1	.....	.....	.....	.....	-32.2	1	.....	.....	.....	.....	.....	.....	.....	.....
He	4026.352	1.4	.....	.....	-18.3	$\frac{1}{2}$	-30.4	1	-33.1	$\frac{1}{2}$	-55.7	$\frac{1}{2}$	-19.1	1	.....	.....
Un-known	4069.700	0.8	.....	.....	.....	.....	-37.8	1	.....	.....	.....	.....	.....	.....	.....	.....
H δ	4101.890	2.8	.....	.....	.....	.....	-36.3	$\frac{1}{2}$	.....	.....	.....	.....	.....	.....	.....	.....
He	4121.016	1.1	.....	.....	.....	.....	.....	.....	-67.7	$\frac{1}{2}$	.....	.....	.....	.....	.....	.....
Si	4128.211	0.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	-41.8	4	-18.0	1
He	4143.928	0.6	.....	.....	.....	.....	.....	.....	-12.5	$\frac{1}{2}$	-25.0	1	.....	.....	-15.4	1
C	4267.301	0.8	.....	.....	-3.2	$\frac{1}{2}$	-45.6	$\frac{1}{2}$	.....	.....	.....	.....	.....	.....	.....	.....
O	4317.272	0.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	-43.3	1	.....	.....
H γ	4340.634	2.3	.....	.....	-30.5	2	-30.5	2	-44.1	2	-54.2	2	-42.9	4	.....	.....
O	4367.012	0.7	.....	.....	.....	.....	.....	.....	-64.4	3	.....	.....	.....	.....	.....	.....
He	4388.100	1.4	-31.6	$\frac{1}{2}$	-26.9	$\frac{1}{2}$	-22.2	$\frac{1}{2}$	.....	.....	-43.3	3	-41.0	1	.....	.....
O	4417.121	0.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	-22.6	$\frac{1}{2}$
He	4471.676	1.3	.....	.....	-14.9	4	-58.3	4	-14.9	$\frac{1}{2}$	.....	.....	-53.3	4	-59.5	$\frac{1}{2}$
Mg	4481.397	1.2	-35.0	3	-37.5	3	-61.2	3	.....	.....	-51.2	4	-58.8	2	-38.8	$\frac{1}{2}$
Fe?	4549.642	1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	-56.3	2	.....	.....
Fe?	4584.191	0.7	.....	.....	.....	.....	.....	.....	-49.0	$\frac{1}{2}$	.....	.....	.....	.....	.....	.....
H β	4861.527	4.2	.....	.....	.....	.....	.....	.....	.....	.....	-66.8	$\frac{1}{2}$	.....	.....	-50.9	$\frac{1}{2}$

These give, together with the velocities already known, the following table:—

RADIAL VELOCITIES OF ϵ DELPHINI

Place	Plate	Date	Velocity
			km.
Lick		1902 July 2.864.....	-22
Yerkes		11.747.....	-27.8
		16.784.....	-24.7
		23.832.....	-26.4
		31.697.....	-26.0
Lick		1910 Aug. 29.740.....	-16
		Sept. 4.830.....	-12
		Oct. 23.726.....	-22
		24.670.....	-20
		30.695.....	-16
		1911 June 20.925.....	-14
Ottawa	9163	1920 June 30.636.....	-20.2 \pm 1.0
	9164	.667.....	-10.3 \pm 3.2
	9165	.697.....	-32.6 \pm 3.2
	9173	July 9.706.....	-38.6 \pm 4.8
	9174	.762.....	-37.5 \pm 2.8
	9175	.790.....	-36.1 \pm 2.4
	9176	.819.....	-19.4 \pm 5.0

Owing to the rather poor quality of the spectra, no short-period velocity can be detected.

55 CYGNI

The spectrum of 55 Cygni is good. The lines in it are well-defined and numerous, although a little wider than in the best spectra of early class B stars we have encountered. The results of our measures are given in the following table:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 55 CYGNI

Element	λ	Width, angstroms	9192		9209		9210		9211	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
<i>Hδ</i>	4101.890	3.4							-23.2	1
<i>He</i>	4143.928	2.2							-33.6	1
<i>C</i>	4267.301	2.6							-40.3	2
<i>Fel</i>	4325.939				-49.9	1			+13.3	1
<i>Hγ</i>	4340.634	2.8			-31.6	5	-32.8	2	-15.8	7
<i>He</i>	4388.100	2.5			-40.9	6	-36.3	6	-29.2	6
<i>He</i>	4471.676	3.2	-19.8	3	-28.5	6	-53.3	8	-26.0	6
<i>Mg</i>	4481.397	2.7	-36.2	2	-37.5	7	-5.0	9	-18.7	9
<i>N</i>	4508.455		-22.9	1						
<i>Si</i>	4552.636	2.8			-34.1	4	-38.0	2	-11.8	2
<i>Si</i>	4567.897	2.8							-31.7	4
<i>Si</i>	4574.791	2.9							+12.0	1
<i>O</i>	4661.728						-56.4	1		
<i>He</i>	4713.308						-39.1	3	-8.7	2

The last three plates have been remeasured by Mr. Thorn; these, together with the velocities above, give us the following table:—

RADIAL VELOCITIES OF 55 CYGNI

Plate	Date	Velocity by Henroteau	Velocity by Thorn
9192	1920 July 20.619.....	-16.7	.....
9209	Aug. 3.752.....	-29.5	-31.7
9210	.799.....	-26.7	-37.0
9211	.850.....	-15.6	-24.0

To these may be added the velocity given by Dr. Campbell* in his article "On the Motions of the Brighter Class B Stars," which is

-3.9 km.

55 Cygni is thus a spectroscopic binary of very short period, probably to be classified among the β Canis Majoris type.

* L. O. B., Vol. 6, p. 116.

66 CYGNI

The lines in the spectrum of 66 Cygni are very wide and diffuse. On the wide absorption of $H\beta$, however, there is a narrower but strong emission line, while two weak emission lines on a wide absorption line are suspected at $H\gamma$. Dr. Merrill investigated this star at the Lick Observatory† and found interesting peculiarities concerning the bright lines.

The two plates we have obtained have been measured with a microscope of very low magnification, and give us the following detailed measures:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 66 CYGNI

Element	λ	Width of absorption lines, angstroms	9242		9243	
			Vel.	Wt.	Vel.	Wt.
O.....	4072.400	1.1	.....	.....	-13.5	1
He.....	4143.928	.....	.....	.....	-4.8	1
He.....	4471.676	2.6	.....	.....	-45.9	3
N.....	4630.703	.....	-6.9	1	.....	.....
He.....	4713.308	3.2	+7.2	2	-43.5	1
$H\beta$	4861.527	9.5	-30.2	2	-49.3	1

For the radial velocity given by $H\beta$ the emission line has been measured. These, with velocities published formerly, give us the following table:—

RADIAL VELOCITIES OF 66 CYGNI

Place	Plate	Date	Velocity	Remarks
Lick	1896 June 23.93.....	+8.6	Campbell's Velocities
		24.91.....	+16.0	
		29.88.....	+11.2	
		July 1.90.....	+6.1	
		6.86.....	-2.1	
		7.88.....	+3.3	
Ottawa	1911 June 20.00.....	-8	
		1920 Aug. 19.622.....	-7.9	
		671.....	-32.9	

On account of the poor quality of the spectrum a great many plates would have to be taken to find out whether or not 66 Cygni is a very short-period binary; if it were, however, it should be of the greatest interest on account of its bright emission lines.

† L. O. B., Vol. 7, p. 172.

9 CEPHEI

Only one radial velocity has previously been published for this star—in Dr. Campbell's article "On the Motions of the Brighter Class B Stars" as -12.5 km.* No date is given for this velocity.

We have on several nights secured a number of spectrograms of 9 Cephei. Their measures seem to indicate that the star could be classified among those of the β Canis Majoris type. A variation of widths of the spectral lines is also strongly suspected.

The detailed measures of the spectrograms of 1921, October 23, are given in the following table:—

Element	λ	Width, angstroms, on plate 9857	9857		9858		9859		9860	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
<i>K</i> (Ca).....	3933.825	0.7	-27.6	1	.....	.....	.....	.....	.....	.....
<i>He</i>	4026.352	0.9	-33.1	2	-43.5	1	.....	.....	.....	.....
<i>Hδ</i>	4101.890	0.8	-26.0	3	-23.3	1	.....	.....	.....	.....
<i>He</i>	4143.928	0.7	-41.3	4	-7.7	1	.....	.....	.....	.....
<i>Hγ</i>	4340.634	1.6	-7.9	3	-45.2	5	-41.8	4	-31.6	2
<i>He</i>	4388.100	0.4	-44.5	3	-24.6	2	-29.3	1	-51.5	3
<i>O</i>	4415.076	.....	.....	.....	.....	.....	.....	.....	-47.6	2
<i>N</i>	4447.163	.....	.....	.....	-36.6	1	.....	.....	.....	.....
<i>He</i>	4471.676	1.4	-18.6	4	-21.1	4	-48.4	5	-52.1	7
<i>Mg</i>	4481.397	0.6	-32.5	2	.....	.....	.....	.....	-23.7	1
<i>Si</i>	4552.636	.....	.....	.....	+1.3	2	.....	.....	-10.5	2
<i>He</i>	4713.308	0.7	+5.8	1	.....	.....	-31.9	2	-34.8	2
<i>Hβ</i>	4861.527	2.3	+22.3	1	-20.7	2	-22.3	1	-38.2	2

The velocities obtained for the different nights are given in the following table:—

RADIAL VELOCITIES OF 9 CEPHEI

Plate	Date	Velocity	Number of lines measured
		km.	
9212	1920 Aug. 4.609.....	-19.4 \pm 3.2	5
9213	.....653.....	-16.8 \pm 4.5	3
9214	.....699.....	-20.8 \pm 5.9	6
9215	.....756.....	-52.8 \pm 8.0	4
9217	.....854.....	-33.5 \pm 3.6	6
9849	1921 Oct. 13.577.....	-38.8 \pm 5.6	5
9850	.....644.....	-25.6 \pm 5.0	7
9851	.....722.....	-23.2 \pm 4.3	5
9852	14.562.....	-23.5 \pm 2.8	6
9855	.....695.....	-13.3 \pm 5.5	5
9856	.....740.....	-21.5 \pm 5.1	5
9857	23.524.....	-29.0 \pm 2.8	10
9858	.....566.....	-30.6 \pm 3.5	9
9859	.....608.....	-44.3 \pm 2.8	5
9860	.....649.....	-45.2 \pm 3.4	8
9862	25.520.....	-25.6 \pm 2.9	7
9863	.....562.....	-45.4 \pm 2.7	7
9864	.....603.....	-39.8 \pm 3.8	8
9865	.....645.....	-47.0 \pm 7.3	7
9866	.....722.....	-26.9 \pm 3.8	9
9867	.....765.....	-39.9 \pm 3.3	3

* L. O. B., Vol. 6, p. 116.

16 PEGASI

The spectrum of 16 Pegasi is very poor; the lines are wide and diffuse. No radial velocity has ever been published for the star. Our detailed measures are given in the following table:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRA OF 16 PEGASI

Element	λ	Width, angstroms	9218		9219		9221		9222	
			Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
He	4143.928	1.1					-53.8	1		
H γ	4340.634	2.2	+23.7	1	-72.3	1	-22.6	2	-35.0	1
He.....	4388.100	1.2	-44.5	6	-18.7	1	-23.4	1	-39.8	2
N.....	4432.900	1.2					+12.1	1		
He.....	4471.676	2.6	-58.3	4	-62.0	1	-48.4	4	-98.0	1
Mg.....	4481.397	1.4							-28.7	6

These give the following velocities:—

RADIAL VELOCITIES OF 16 PEGASI

Plate	Date	Velocity
		km.
9218	1920 Aug. 11.592.....	-22.7 \pm 10.5
9219	.642.....	-14.8 \pm 14.5
9221	.742.....	-19.2 \pm 5.1
9222	.802.....	-18.3 \pm 8.0

The velocity of the star, apparently, does not vary for the night (allowance being made for the poor quality of the spectrum).

1 ANDROMEDAE

The spectrum of 1 Andromedae, although mentioned as belonging to class B3, does not resemble the usual spectra of early class B stars. The hydrogen lines in it are wide, but have a sharp centre characterizing an absorption of exceptional intensity. Other lines are present, but they are weak, wide and so diffuse that they cannot be measured either for radial velocity or for width. Among them we can recognize the principal lines of helium, especially at 4388 and 4471, as well as the line of magnesium at 4481. Among the lines of hydrogen, usually H β is the best defined; H γ seems a strong line having ragged edges; while H δ is more diffuse, and H ϵ and succeeding lines of the Balmer series still more diffuse and wide.

1 Andromedae was announced to be a spectroscopic binary by Wright* and fifty velocities were obtained by Harper† at Ottawa. Ludendorff also gave one velocity‡, -20 km.

* L. O. B. No. 20, 1902, Vol. 1.
 † Report of the Chief Astronomer, 1911, p. 191.
 ‡ A. N., Vol. 178, p. 53.

The detailed velocities given by our plates are:—

Element	λ	9392		9393		9394		9395	
		Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
<i>Hδ</i>	4101.890	-18.6	4	-4.6	4	-9.3	2	.....	.....
<i>Hγ</i>	4340.634	-4.5	9	-22.6	8	-20.3	7	.....	.....
<i>Hβ</i>	4861.527	-14.3	7	-6.4	7	-46.1	10	-12.7	7

These give the following velocities:—

RADIAL VELOCITIES OF 1 ANDROMEDAE

Plate	Date	Velocity
9392	1920 Oct. 22.610.....	-19.9
9393	.630.....	-22.0
9394	.653.....	-41.9
9395	.677.....	-21.9

The result given by plate 9394 seems to be rather abnormal. It is to be remarked that Harper never found any period for the variation of velocity of 1 Andromedae; an examination of his spectrograms shows that they are much poorer than ours. The velocity given by Ludendorff agrees well with our three smaller velocities.

β PISCIMUM

Only one radial velocity, +2.3 km. has been given for this star before. It may be found in Campbell's article "On the Motions of the Brighter Class B Stars."* The star is classified as B5 in the Revised Harvard Photometry, where no mention is made of bright lines in the spectrum. Merrill, however, in his article "Class B Stars Whose Spectra Contain Bright Hydrogen Lines,"† gives valuable data about the bright hydrogen lines found in the spectra of β Piscium. He secured three plates of it as follows:—

July 28.00, 1912, on Seed 23, stained.

Aug. 25.82, 1912, on Seed 30.

June 21.95, 1921, on Seed 23, stained.

The last plate measured for radial velocity gave him the result -1 km. His description of those plates follows:—

First plate: *H γ* sharp bright; *H β* sharp bright on very strong absorption; traces of other bright lines.

Second Plate: Hydrogen lines as above; faint *He* absorption.

Third Plate: *H β* bright on strong absorption.

* L. O. B. No. 195, Vol. 6.

† L. O. B. No. 237, Vol. 7.

We secured only one spectrogram of β Piscium. It shows a strong, well-defined emission line on wide absorption for $H\beta$, a well-defined but weaker emission line on wide absorption for $H\gamma$, and a very weak emission line on wide absorption for $H\delta$. Absorption lines of helium, such as 4388 and 4471 and also a well-defined absorption line of magnesium at 4481.

The detailed measure of our plate is given here:—

Element	λ	8798	
		Vel.	Wt.
$H\gamma$	4340.634	+18.1	6
He	4388.100	+46.8	5
He	4471.676	+18.6	4
$H\beta$	4861.527	+36.6	3

After reduction, we have for November 11.640, 1919, the velocity $+2.8 \text{ km.} \pm 4.9 \text{ km.}$

It seems likely, comparing this velocity with that of Campbell and that of Merrill, that β Piscium has a constant radial velocity.

ψ^2 AQUARI

The spectrum of ψ^2 Aquarii is very poor and has exceedingly wide and diffuse lines. We secured only one spectrogram, which gives the following detailed measures:—

LINES, THEIR WIDTHS AND VELOCITIES IN SPECTRUM OF ψ^2 AQUARI

Element	λ	Width, angstroms	8797	
			Vel.	Wt.
$H\delta$	4101.890	6.3	+ 8.4	1
$H\gamma$	4340.634	7.5	+23.7	2
He	4388.100	6.0	.....	.....
He	4471.676	5.6	.....	.....
$H\beta$	4861.527	9.5	+ 9.5	1
He	4922.100	11.9	.....	.....

The helium lines are much more diffuse than the hydrogen lines. The velocity furnished by our plate, which is the only velocity known, will then be

Plate	Date	Velocity
8797	1919 Nov. 11.591.....	-11.1 ± 3.6

On account of the very poor quality of the lines in the spectrum we did not take more spectrograms.

THE STARS OF THE β CANIS MAJORIS TYPE

The rapid survey we have made of 67 stars shown in the last three papers on early class B stars has led us to believe a certain number of them to be of the β Canis Majoris type. In conclusion we may give the following table of those known or suspected to be stars of that type:—

STARS OF THE β CANIS MAJORIS TYPE (KNOWN OR SUSPECTED)

HR	Star	R. A. (1900)		Decl. (1900)		Visual Mag.	Spect.	Remarks
		h	m	°	'			
779	δ Ceti.....	2	34.4	— 0	6	4.04	B2	
1149	20 Tauri.....	3	39.9	+24	4	4.02	B5	
1320	μ Tauri.....	4	10.1	+ 8	39	4.32	B5	
1463	ν Eridani.....	4	31.3	— 3	33	4.12	B2	
1641	η Aurigae.....	4	59.5	+41	6	3.28	B3	
1810	114 Tauri.....	5	21.6	+21	51	4.83	B3	
1931	σ Orionis.....	5	33.7	— 2	39	3.78	B	
2294	β Canis Majoris.....	6	18.3	—17	54	1.99	B1	Discovered by S. Albrecht.
2344	10 Monocerotis.....	6	23.0	— 4	42	4.98	B3	
2387	4 Canis Majoris.....	6	27.6	—23	21	4.35	B1	
2490	42 Camelopardalis....	6	40.5	+67	41	5.04	B3	
2571	15 Canis Majoris.....	6	49.2	—20	6	4.66	B1	Our unpublished data.
5062	g Ursae Majoris.....	13	21.2	+55	30	4.02	A5	Discovered by E. B. Frost.
6084	σ Scorpii.....	16	15.1	—25	21	3.08	B1	Discovered by Fr. Selga.
6453	θ Ophiuchi.....	17	15.9	—24	54	3.37	B3	
7298	η Lyrae.....	19	10.4	+38	58	4.46	B3	
7372	2 Cygni.....	19	20.2	+29	26	4.86	B2	
7426	8 Cygni.....	19	28.1	+34	14	4.85	B3	
7447	ϵ Aquilae.....	19	31.6	— 1	31	4.28	B5	
7977	55 Cygni.....	20	45.5	+45	45	4.89	B2	
8130	τ Cygni.....	21	10.8	+37	37	3.82	F	Discovered by J. S. Paraskévopoulos.
8238	β Cephei.....	21	27.4	+70	7	3.32	B1	Discovered by E. B. Frost.
8273	9 Cephei.....	21	35.2	+61	38	4.87	B2	
8640	12 Lacertae.....	22	37.0	+39	43	5.18	B2	Discovered by R. K. Young.

To these stars we hope to add a few more from a study of later class spectra (F, G and K), of which we have already secured a considerable number of plates (all taken by the author during the year 1921). Then we will proceed to the complete study of a great many of the above stars; we have already found that they are far from showing the same characteristics. Studies of β Canis Majoris and σ Scorpii may be found in the Lick Observatory Bulletins,* while a more complete study of the latter is given in the Publications of the Dominion Observatory, Vol. V, No. 7. A study of β Cephei has been published by Dr. C. C. Crump,† while studies of 12 Lacertae have been published by Dr. R. K. Young, both in the Publications of the Dominion Observatory, Ottawa, and of the Astrophysical Observatory, Victoria.‡

We have also to mention here the interesting photo-electric studies made of some of these stars by Professor P. Guthnick, now director of the Berlin-Babelsberg Observatory.**

* L. O. B., Vol. 9, pp. 155 and 173.

† Pub. Detroit Obs., Vol. 2, 1916, p. 144.

‡ Pub. Dom. Obs., Vol. 3, No. 3, and Pub. Dom. Ap. Obs., Vol. 1, No. 2.

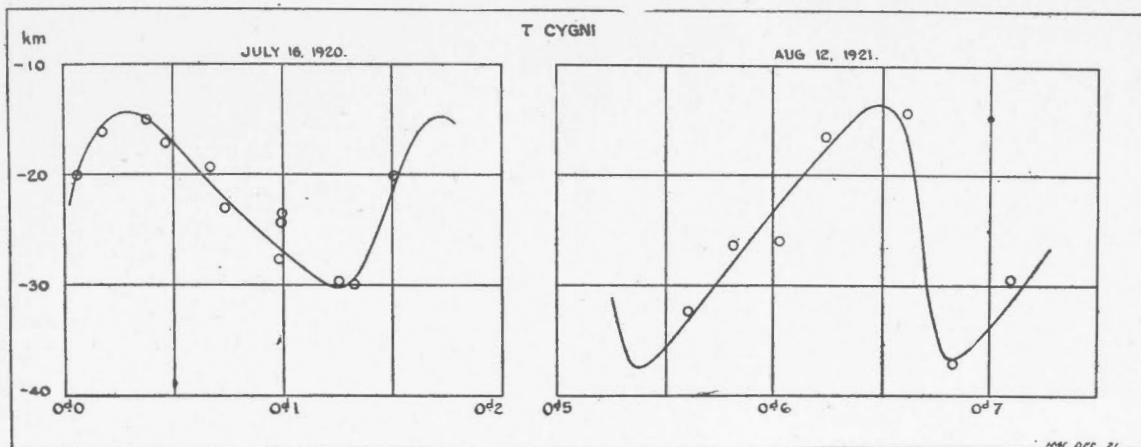
** A. N. Jubiläumnummer zum Hunder. Best., p. 12.

Up to the time of writing, we have already secured about one hundred plates of δ Ceti and sixty-two plates of τ Cygni. The measures we have of δ Ceti show most peculiar irregularities such as have not been found in other systems investigated; while τ Cygni, which gives excellent measures, promises to be of the greatest interest. Let us give here the radial velocities we have obtained for this last star on August 12, 1921.

OTTAWA RADIAL VELOCITIES OF τ CYGNI

Plate	Date	Velocity
		km.
9772	1921 Aug. 12·560.....	-32·3
9773	·582.....	-26·3
9774	·603.....	-26·0
9775	·625.....	-16·7
9776	·662.....	-14·2
9777	·683.....	-37·4
9778	·708.....	-29·3

The comparison of the velocity curve we obtain from these, with the velocity curve obtained by J. S. Paraskévopoulos (see figures) is most interesting.



His velocities are:—

YERKES RADIAL VELOCITIES OF τ CYGNI*

Plate	Date	Velocity
		km.
IB 5859	1920 July 16·597.....	-23·98
5860	·630.....	-29·95
5861	·659.....	-15·88
5862	·686.....	-16·54
5863	·713.....	-22·99
5864	·740.....	-22·67
5865	·766.....	-29·38
5866	·790.....	-20·37
5867	·819.....	-14·66
5868	·850.....	-19·08
5869	·881.....	-27·85

* Ap. J., Vol. 53, p. 144.

Comparing the two curves we see that there is first a decided change of amplitude, but also a striking change of appearance, whereas, in the first curve, the long branch is descending, in the second it is ascending. The variation shown in these two cases bears a striking resemblance to what we have found in the long-period velocity curve of σ Scorpii,* change of amplitude and reversal of the curve. Is it a tipping of the plane of the orbit allowing a maximum to become a minimum? We hope that the number and the variety of the different systems will help us to understand what they really are.

My thanks are due to Mr. J. P. Henderson for securing a certain number of the spectrograms of 1919 and 1920, and to Mr. W. A. Thorn, who measured a certain number of them.

*Pub. Dom. Obs., Vol. 5, No. 7.

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