DEPARTMENT OF THE INTERIOR

CANADA

PUBLICATIONS

OF THE

Dominion Observatory

OTTAWA

OTTO KLOTZ, LL.D., D.Sc., DIRECTOR

Volume IV

OTTAWA
GOVERNMENT PRINTING BUREAU
1920

CONTENTS OF VOL. IV.

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 1

ORBIT OF THE SPECTROSCOPIC BINARY χ AURIGÆ

AND A NOTE ON 12 LACERTÆ

BY REYNOLD K. YOUNG, Ph. D.

The binary character of χ Aurigæ ($\alpha = 5^h\ 26^m$, $\delta = +32^\circ\ 7'$, mag. 4.88, type B1) was announced by Frost and Adams in the *Astrophysical Journal* in 1903. An orbit has been determined from eighty-eight single-prism spectrograms secured at this observatory during the years 1913, 1914, 1915, and 1916. An idea of the spectrum may be obtained from Table I, which gives the wave-lengths of the lines used in making the reductions, the number of times each line was measured and other data necessary for correcting the wave-lengths by the usual method of making the weighted mean of the residuals equal to zero. The residuals quoted are taken in the sense, observed minus the mean of the plate. In addition to the lines given in this table, the *H* and *K* lines of calcium are present and generally were measured, but they were not included with the rest of the lines for reasons which will appear later. On well-exposed plates all of the lines given are fairly sharp. Those due to silicon and some of those due to helium are faint, which accounts for the small number of times they were measured.

The velocities obtained at the Yerkes and Ottawa observatories follow in Tables II and III. The headings of the columns in these tables are self-explanatory. The residuals, as given under O–C, were obtained graphically from the final curve, and so may occasionally be a tenth of a kilometre or so in error.

TABLE I

Element	Wave-Length	Arithmetic Residual	Algebraic Residual	Total Weight	Number of Times Measured
Helium	3964·875	7·5	+2·1	10½	32
Helium	4009·417	6·8	+2·1	8	23
Helium	4026·352	5·7	+2·9	39½	79
Hydrogen	4101·890	5·8	−0·6	30½	64
Helium	4121·016	8·3	−0·9	5½	19
Silicon	4128·211	10·0	−3·2	9	29
Silicon	4131·047	6·2	−2·7	7¼	24
Helium	4143·928	7·7	−3·1	22½	61
Carbon	4267·301	7·1	+2·8	13½	40
Hydrogen	4340·634	6·7	−3·0	48¼	83
Helium	4388·100	7·2	−1·3	37	76
Helium	4471·676	6·1	+3·2	63	86
Magnesium	4481·400	5·7	−1·2	34	72

TABLE II

YERKES OBSERVATIONS OF χ AURIGÆ

Date	Julian Day	Velocity	O-C
1903			
Sept. 5..	2,416,363·825	+24·2	+12·8
Oct. 10..	398·782	+12·2	− 2·4
Oct. 16..	404·844	+13·8	− 1·2

TABLE III

OTTAWA OBSERVATIONS OF χ AURIGÆ

Plate	Observer*	Date	Julian Day	Velocity	Weight	O-C	Velocity *H* and *K* Lines	Weight
		1913						
5791	P1	Nov. 4........	2,420,076·915	−19·8	1	+ 0·5	−10·6	1
5798	Y	Nov. 5........	077·872	−17·5	1	+ 2·7	−11·8	½
5804	Y	Nov. 6........	078·719	−20·6	1	− 0·5	....	....
5818	P1	Dec. 8........	110·774	−19·2	½	− 3·4	−12·7	1
5834	Y	Dec. 18........	120·628	− 9·8	½	+ 4·5	− 9·5	1
5849	C	Dec. 22........	124·780	−22·3	½	− 8·7	− 1·9	½
		1914						
5873	Y	Jan. 1........	134·729	−14·6	½	− 2·7	....	....
5894	P	Jan. 21........	154·705	−14·5	½	− 5·9	+ 2·7	½
5922	P1	Feb. 9........	173·689	−15·2	½	− 9·7	....	....
5925	Y	Feb. 11........	175·663	+ 1·5	1	+ 6·7	....	....
5939	Y	Feb. 15........	179·589	− 2·5	1	+ 2·0	....	....
5957	C–P1	Feb. 23........	187·665	+ 6·7	1	+ 9·9	+ 1·8	½
5973	Y	Mar. 11........	203·576	− 8·4	1	− 7·7	+ 1·3	½
6397	Y	Sept. 17........	393·889	+ 7·6	1	−10·2	− 6·0	1
6460	Y	Oct. 1........	407·839	+17·6	1	− 0·3	+ 8·9	1
6470	C	Oct. 2........	408·833	+29·1	½	+11·3	+15·2	½
6483	H	Oct. 4........	410·822	+18·0	1	+ 0·1	+12·5	1
6486	Y	Oct. 6........	412·914	+22·2	1	+ 4·3	+16·9	1
6489	Y	Oct. 11........	417·887	+21·1	1	+ 3·3	+11·0	1
6508	H	Oct. 20........	426·791	+19·0	1	+ 1·3	....	....
6526	Y	Oct. 22........	428·911	+24·7	1	+ 7·1	+13·6	1
6562	H	Nov. 17........	454·824	+17·8	1	+ 1·2	+ 9·9	1
6587	P–Y	Nov. 28........	465·748	+ 5·2	1	−12·5	+ 3·2	½
6593	C–P1	Dec. 4........	471·757	+20·8	1	+ 5·8	+12·3	1
6599	Y	Dec. 5........	472·759	+16·4	1	+ 1·4	+17·5	1
6604	Y–H	Dec. 6........	473·627	+13·3	1	− 1·6	+ 7·1	½
6617	C–P1	Dec. 11........	478·733	+10·7	1	− 3·7	+10·5	1
6627	Y	Dec. 15........	482·637	+14·6	1	+ 0·6	− 3·7	1
6639	P1	Dec. 16........	483·757	+15·8	1	+ 2·0	− 0·1	1

TABLE III

OTTAWA OBSERVATIONS OF χ AURIGÆ—*Continued*

Plate	Observer*	Date	Julian Day	Velocity	Weight	O–C	Velocity *H* and *K* Lines	Weight
		1914						
6643	H	Dec. 17........	2,420,484·654	+14·5	1	+ 0·8	+11·2	1
6646	Y	Dec. 20........	487·496	+15·3	1	+ 1·9	+ 3·4	½
6652	Y	Dec. 22........	489·592	+10·4	1	− 2·8	+ 6·2	1
6667	Y	Dec. 30........	497·571	+16·2	1	+ 3·9	+ 8·9	1
		1915						
6680	C	Jan. 4........	502·744	+11·7	1	+ 0·2	+ 6·9	1
6702	Y	Jan. 10........	508·592	+ 1·4	1	− 9·1	+ 7·2	1
6731	Y	Jan. 24........	522·609	+ 7·5	1	− 0·5	+ 3·6	½
6750	H–Y	Jan. 28........	526·721	+ 8·1	1	+ 1·0	+ 6·7	1
6783	C	Feb. 12........	541·640	+ 6·2	1	+ 2·1	+ 9·3	1
6788	H	Feb. 17........	546·599	+11·2	1	+ 8·3	+ 8·8	1
6819	Y	Feb. 28........	557·604	− 2·8	1	− 3·2	− 1·1	1
6844	Y	Mar. 7........	564·573	+ 1·7	1	+ 3·2	− 2·6	1
6879	Y	Mar. 19........	576·555	−11·3	1	− 6·8	+ 4·8	1
6896	Y	Mar. 30........	587·528	− 4·8	1	+ 2·3	0·0	1
6919	Y	Apr. 13........	601·536	− 6·8	1	+ 4·1	− 5·6	1
6956	Y	Apr. 28........	616·556	−17·3	1	− 2·7	−18·0	½
7135	Y	July 29........	707·858	−21·8	½	+ 0·7	....	1
7152	H	Aug. 10........	720·851	−24·5	1	− 3·2	....	1
7175	Y	Aug. 26........	736·826	−18·7	1	+ 0·9	....	1
7199	Y	Sept. 2........	743·883	−21·6	1	− 2·8	....	....
7227	Y	Sept. 9........	750·906	−16·8	1	+ 1·1	....	....
7264	P[11]	Sept. 17........	758·875	−11·8	1	+ 5·0	....	....
7280	H	Sept. 21........	762·900	−13·9	1	+ 2·2	− 3·7	½
7316	Y	Sept. 30........	771·881	−22·2	1	− 7·4	−11·7	½
7323	Y	Oct. 9........	780·816	− 7·1	1	+ 6·3	−12·9	½
7345	C	Oct. 15........	786·816	− 2·2	1	+10·3	....	....
7364	Y	Oct. 24........	795·892	−12·2	1	− 1·2	− 0·6	½
7373	Y	Nov. 3........	805·622	− 9·8	1	− 0·3	− 6·6	1
7384	Y	Nov. 6........	808·862	−14·6	1	− 5·7	....	....
7401	H	Nov. 12........	814·740	− 5·3	1	+ 2·6	+10·1	1
7415	C	Nov. 17........	819·625	−16·6	½	− 9·5	....	....
7429	Y–C	Nov. 24........	826·708	− 1·4	1	+ 4·4	− 2·4	½
7440	Y	Dec. 3........	835·570	+ 6·4	½	+10·7	....	....
7447	C	Dec. 10........	842·622	− 4·9	1	− 1·7	+ 1·5	1
7454	P	Dec. 20........	852·649	− 9·2	1	− 7·7	− 3·9	½
7458	Y	Dec. 28........	860·651	+ 3·0	1	+ 3·2	− 8·0	½
		1916						
7475	C	Jan. 7........	870·514	− 5·8	1	− 7·0	+ 4·5	1
7481	H	Jan. 13........	876·569	− 2·0	1	− 4·0	+ 1·8	½
7494	Y	Jan. 28........	891·574	+ 2·6	1	− 1·6	+ 0·3	1
7502	H	Feb. 3........	897·728	+12·6	1	+ 7·6	+12·6	1
7504	Y	Feb. 10........	904·584	+ 6·2	1	+ 0·2	+11·6	1
7510	P	Feb. 19........	913·669	+13·5	1	+ 6·3	....	....
7512	Y	Feb. 20........	914·501	+ 9·4	1	+ 3·1	+ 5·3	1
7517	C	Feb. 23........	917·629	+ 6·5	1	− 1·1	+ 8·5	1
7527	Y	Feb. 29........	923·524	+ 1·8	1	− 6·6	+ 5·4	1

TABLE III

OTTAWA OBSERVATIONS OF χ AURIGÆ—*Concluded*

Plate	Observer*	Date	Julian Day	Velocity	Weight	O–C	Velocity *H* and *K* Lines	Weight
		1916						
7532	C	Mar. 1........	2,420,924·501	+ 4·8	1	− 3·7	− 2·0	½
7536	H	Mar. 2........	925·624	+ 8·5	1	− 0·1	+ 3·9	1
7539	Y	Mar. 5........	928·534	+ 0·9	1	− 8·1	+ 6·1	1
7542	C	Mar. 10........	933·535	+10·8	1	− 1·3	+10·1	½
7549	Y	Mar. 17........	940·597	+11·5	1	+ 1·2	+ 4·2	1
7550	Y	Mar. 17........	940·642	+ 8·8	1	− 1·5	+ 5·5	1
7558	Y–H	Mar. 19........	942·637	+ 8·5	1	− 2·1	+ 9·2	½
7562	Y	Mar. 21........	944·510	+14·0	1	+ 3·2	+11·7	1
7571	H	Mar. 23........	946·618	+14·8	1	+ 3·8	+ 6·5	1
7585	Y	Mar. 30........	953·575	+ 7·8	1	− 4·0	+ 7·8	1
7594	Y	Apr. 2........	956·572	+ 9·0	1	− 3·0	+ 3·7	1
7601	H	Apr. 5........	959·525	+16·5	1	+ 4·2	+13·0	1
7624	Y	May 2........	986·548	+ 9·3	1	− 5·5	+ 0·3	½
7632	H	May 4........	988·555	+26·1	½	+11·2	+17·4	½

*C=Cannon; H=Harper; P[1]=Parker; P=Plaskett, J. S.; P[11]=Plaskett, H. H.; Y=Young

MEASURES OF χ AURIGÆ

λ	5791		5798		5804		5818		5834		5849		5873	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	−29·1	1	−29·9	½	...	...	−15·4	1	− 7·2	1	+ 2·8	½	...	...
3964·875	−31·7	¼	...	...	...	...	...	...	− 8·0	½	...	...	...	...
4009·417	−49·0	½	...	...	...	...	...	...	...	...	...	...	...	...
4026·352	−33·4	1	−18·0	½	−35·1	½	−22·9	½	− 3·1	½	−15·3	½	+ 3·8	½
4101·890	−35·6	½	−40·4	½	−26·0	½	−22·5	½	...	...	...	...	...	...
4121·016	−25·4	¼	−45·0	¼	−25·4	½	...	...	...	...	...	...	...	...
4128·211	−53·0	¼	...	...	−45·9	¼	...	...	...	...	...	...	...	...
4131·047	−31·3	¼	...	...	...	...	...	...	...	...	...	...	...	...
4143·928	−10·0	¼	−24·8	¼	−36·7	¼	−10·8	½	...	...	...	...	...	...
4267·301	...	...	−28·5	½	−48·2	¼	...	...	...	...	...	...	...	...
4340·634	−35·8	½	−33·5	½	...	...	−18·8	½	− 9·4	1	−15·0	½	− 2·3	¼
4388·100	−38·2	¼	−40·6	1	−47·8	½	...	...	...	...	−13·5	½	+10·5	¼
4471·676	−53·1	1	−31·6	½	−44·3	½	−34·5	½	...	...	−22·3	1	− 2·5	½
4481·400	−31·9	¼	−42·3	½	−44·6	½	...	...	...	...	...	...	−15·1	½
Weighted mean	− 38·40		− 35·60		− 38·48		− 21·88		− 7·47		− 17·68		− 2·42	
V_a	+ 18·94		+ 18·57		+ 18·21		+ 3·07		− 2·06		− 4·22		− 9·30	
V_d	− 0·11		− 0·15		− 0·07		− 0·07		0·00		− 0·16		− 0·12	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 19·8		− 17·5		− 20·6		− 19·2		− 9·8		− 22·3		− 12·1	
H and *K*	− 10·6		− 11·8		...		− 12·7		− 9·5		− 1·9		...	

MEASURES OF χ AURIGÆ—*Continued*

λ	5894		5922		5925		5939		5957		5973		6397	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	+21·4	½	......		......		......		+30·4	½	+31·3	½	−35·0	½
3964·875	......		......		......		+24·2	¼	......		......		......	
3968·625	......		......		......		......		......		......		−25·5	½
4026·352	+11·4	¼	......		+27·2	¼	+32·5	½	+28·1	½	+22·8	½	+ 6·9	½
4101·890	+ 4·7	¼	......		+37·6	¼	+16·0	½	......		+22·6	½	− 5·6	½
4121·016	......		......		+12·4	¼	+ 5·7	¼	......		......		......	
4128·211	......		......		......		+ 4·8	¼	......		......		......	
4131·047	......		......		......		+22·1	½	......		......		......	
4143·928	......		......		+31·1	¼	+23·4	¼	+22·4	½	+13·6	¼	......	
4267·301	......		......		+30·1	¼	+28·9	¼	......		+21·5	¼	−33·0	½
4340·634	− 7·9	½	+11·4	¼	+43·4	½	+37·6	½	+36·4	½	+19·3	½	−27·0	½
4388·100	+22·4	¼	+24·7	¼	+17·7	¼	+27·1	½	+27·1	½	+16·5	½	−20·1	½
4471·676	+12·5	½	+ 2·5	½	+21·2	½	+43·7	½	+44·5	1	+33·7	½	−22·3	1
4481·400	− 5·0	½	......		+17·6	¼	+10·1	½	+44·1	½	+15·2	¼	−24·9	1
Weighted mean	+ 4·18		+ 10·26		+ 27·52		+ 24·48		+ 35·30		+ 21·55		− 21·46	
V_a	− 18·42		− 25·00		− 25·54		− 26·60		− 28·08		− 29·54		+ 29·22	
V_d	0·00		− 0·20		− 0·18		− 0·10		− 0·22		− 0·15		+ 0·11	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 14·5		− 15·2		+ 1·5		− 2·5		+ 6·7		− 8·4		+ 7·6	
H and *K*	+ 2·7		......		......		......		+ 1·8		+ 1·3		− 6·0	

MEASURES OF χ AURIGÆ—*Continued*

λ	6460		6470		6483		6486		6489		6508		6526	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	−19·1	1	−12·7	½	−17·5	½	− 8·7	1	−15·1	1	...	...	− 9·5	1
3964·875	...	...	...	...	...	...	...	...	...	...	−22·9	½	...	...
3968·625	...	...	...	...	−14·0	1	− 9·8	½	...	...	...	...	−20·5	½
4009·417	− 9·6	½	+10·2	½	...	...	...	...	0·0	½	+ 3·4	½	...	...
4026·352	0·0	½	+ 0·9	½	−22·7	½	+ 3·4	½	...	...	−16·5	½	+ 1·7	1
4101·890	− 6·5	½	− 6·5	½	−16·6	½	−22·3	½	...	...	−17·6	½	+ 3·8	1
4121·016	...	...	− 4·7	¼	...	...	...	...	...	...	+ 4·7	½	− 9·4	½
4128·211	−22·8	½	...	...	...	...	...	...	− 4·8	½	...	...	+12·3	½
4131·047	−18·1	½	...	...	...	...	...	...	...	...	...	...	...	...
4143·928	− 5·9	½	+ 5·8	½	−10·5	½	− 1·9	½	−11·5	½	...	...	+ 9·6	½
4267·301	...	...	...	...	...	...	...	...	...	...	...	...	+ 7·4	½
4340·634	−21·4	1	+ 5·6	½	−19·1	½	−16·9	½	−10·1	½	− 3·8	½	− 9·0	1
4388·100	− 8·2	½	0·0	½	...	...	+ 4·6	½	...	...	+12·8	½	− 7·0	½
4471·676	− 2·5	1	− 1·2	½	+ 3·7	1	+ 6·2	1	− 3·7	1	+ 1·2	½	+ 7·4	1
4481·400	− 7·4	½	− 2·5	½	− 5·0	½	− 9·9	½	− 1·2	½	...	...	...	...
Weighted mean	− 10·53		+ 1·24		− 9·64		− 3·82		− 5·08		− 5·01		+ 1·59	
V_a	+ 28·18		+ 28·05		+ 27·75		+ 26·39		+ 26·43		+ 24·19		+ 23·50	
V_d	+ 0·12		+ 0·14		+ 0·14		− 0·07		0·00		+ 0·14		− 0·14	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 17·6		+ 29·1		+ 18·0		+ 22·2		+ 21·1		+ 19·0		+ 24·7	
H and *K*	+ 8·9		+ 15·2		+ 12·5		+ 16·9		+ 11·0		...		+ 13·6	

MEASURES OF χ AURIGÆ—*Continued*

λ	6562		6587		6593		6599		6604		6617		6627	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	− 2·4	½	− 4·8	½	+11·2	1	+ 8·0	½	+ 3·2	½	+ 8·8	1	− 7·2	½
3964·875	+18·1	¼	+14·0	½	.....	.....	.....	.....	+23·9	¼	+ 8·2	½	+ 5·8	¼
3968·625	+ 5·0	½	.....	.....	+ 3·5	1	+18·2	½	.....	.....	+ 9·9	½	+ 5·8	¼
4009·417	.....	.....	+18·9	¼	+12·9	½	.....	.....	+18·9	½	.....	.....	.....	.....
4026·352	+ 3·5	¼	+ 0·8	½	+11·3	½	+16·2	½	+18·3	½	+22·6	½	+13·1	½
4101·890	.....	.....	+ 6·5	½	+21·4	½	0·0	½	− 1·9	½	+ 6·5	½	+31·7	½
4121·016	.....	.....	.....	.....	+ 6·6	¼	.....	.....	.....	.....	.....	.....	.....	.....
4128·211	.....	.....	− 4·8	¼	+23·8	¼	.....	.....	.....	.....	.....	.....	.....	.....
4131·047	.....	.....	+ 1·9	¼	.....	.....	+15·3	¼	.....	.....	.....	.....	.....	.....
4143·928	− 4·8	¼	−16·4	¼	+28·0	¼	− 1·9	¼	− 2·9	¼	+ 1·0	½	+ 1·0	½
4267·301	.....	.....	.....	.....	+22·4	¼	− 6·4	¼	.....	.....	.....	.....	+31·0	¼
4340·634	+20·3	¼	−13·6	¼	+18·1	1	− 4·5	½	+ 4·5	½	+10·2	½	+ 6·8	½
4388·100	.....	.....	.....	.....	+ 4·7	½	+35·1	¼	+11·7	½	+19·9	½	+10·5	½
4471·676	+ 6·2	½	−24·9	½	+ 9·9	½	+33·6	½	+ 6·8	1	+ 8·7	1	+11·2	½
4481·400	+16·2	¼	−11·3	¼	+21·9	½	+22·5	¼	+ 8·7	¼	+ 6·3	½	+14·0	½
Weighted mean	+ 9·39		− 2·88		+ 15·88		+ 11·94		+ 9·41		+ 9·27		+ 15·13	
V_a	+ 8·83		+ 8·32		+ 5·28		+ 4·77		+ 4·32		+ 1·78		− 0·42	
V_d	− 0·07		0·00		− 0·04		− 0·06		− 0·16		− 0·04		+ 0·12	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 17·8		+ 5·2		+ 20·8		+ 16·4		+ 13·3		+ 10·7		+ 14·6	
H and *K*	+ 9·9		+ 3·2		+ 12·3		+ 17·5		+ 7·1		+ 10·5		− 3·7	

MEASURES OF χ AURIGÆ—*Continued*

λ	6639		6643		6646		6652		6667		6680		6702	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	− 0·8	½	+15·2	½	+ 6·4	½	+10·4	1	+16·8	1	+ 9·6	¼	+23·2	1
3964·875	+17·3	½	+20·6	½	....		+15·6	½	....		....		+15·6	¼
3968·625	+ 3·3	½	+10·7	½	....		+10·1	½	+17·4	1	+27·2	¼	+16·5	½
4009·417	....		+ 9·4	¼	....		+17·2	¼	+28·3	¼	....		....	
4026·352	+17·4	½	+25·3	½	+18·3	½	+16·6	½	+35·7	½	....		+25·3	1
4101·890	+23·4	¼	+14·9	½	....		....		+28·0	½	+21·4	¼	+ 2·8	¼
4121·016	....		....		+17·1	¼	....		+18·9	¼	....		....	
4128·211	....		0·0	¼	+ 7·6	¼	+ 3·8	¼	....		....		+22·9	¼
4131·047	....		+10·5	¼	....		+ 7·6	¼	+15·3	¼	....		+26·8	¼
4143·928	+13·5	½	....		+22·2	¼	....		+21·3	1	....		+ 5·8	¼
4267·301	+17·1	¼	+20·3	¼	....		....		+16·0	¼	....		+13·9	½
4340·634	+26·0	½	+ 7·9	½	+15·9	½	+20·3	½	+17·0	1	+14·7	¼	+ 5·7	1
4388·100	+ 9·4	¼	+28·0	½	+28·1	¼	+ 1·2	½	+26·3	½	+18·1	¼	+ 9·4	½
4471·676	+18·7	1	+14·9	½	+ 6·7	½	+18·0	½	+31·7	1	+33·6	¼	+18·7	1
4481·400	+ 2·6	¼	+13·8	½	+31·3	½	+22·5	½	+23·8	½	+28·2	¼	+17·5	½
Weighted mean	+ 17·23		+ 16·16		+ 18·29		+ 14·47		+ 24·41		+ 23·19		+ 15·18	
V_a	− 0·96		− 1·42		− 2·91		− 3·99		− 8·09		− 10·62		− 13·56	
V_d	− 0·15		0·00		+ 0·24		+ 0·14		+ 0·15		− 0·15		+ 0·07	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 15·8		+ 14·5		+ 15·3		+ 10·4		+ 16·2		+ 11·7		+ 1·4	
H and *K*	− 0·1		+ 11·2		+ 3·4		+ 6·2		+ 8·9		+ 6·9		+ 7·2	

MEASURES OF χ AURIGÆ—*Continued*

λ	6731		6750		6783		6788		6819		6844		6879	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	+22·4	½	+27·2	1	+32·0	1	+36·0	1	+30·4	1	+27·2	1	+30·4	½
3964·875	.....	.....	+21·4	¼	.....	.....	+33·7	¼	.....	.....	.....	.....	.....	.....
3968·625	.....	.....	+29·7	½	+42·1	½	+36·3	½	+19·0	¼	.....	.....	+38·8	½
4009·417	+24·9	½	+37·8	¼	.....	.....	.....	.....	.....	.....	+41·2	¼	.....	.....
4026·352	+44·4	¼	+42·7	¼	+27·0	¼	+41·9	½	+26·2	1	+34·0	½	+24·4	½
4101·890	.....	.....	.....	.....	+ 9·3	¼	+41·0	½	+29·9	½	+21·4	½	+ 6·5	½
4121·016	+37·0	¼	+35·1	¼	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4128·211	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+43·9	½	.....	.....
4131·047	.....	.....	+25·8	¼	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4143·928	+19·3	½	+21·3	¼	+48·3	¼	.....	.....	+13·5	½	.....	.....	.....	.....
4267·301	.....	.....	+24·6	¼	.....	.....	.....	.....	+26·7	¼	+43·8	¼	+21·4	¼
4340·634	+24·9	½	+23·8	1	+30·5	1	+30·5	¼	+21·5	½	+22·6	1	+20·4	½
4388·100	+21·1	½	+35·1	½	+31·7	½	+35·1	¼	+42·7	½	+28·1	½	+ 7·0	¼
4471·676	+37·3	½	+36·1	½	+31·1	1	+42·3	½	+31·1	½	+34·8	1	+18·0	½
4481·400	+23·2	½	+27·5	½	+44·4	½	+36·9	½	+13·1	¼	+29·4	½	+27·5	½
Weighted mean	+ 27·34		+ 29·50		+ 32·34		+ 38·49		+ 26·34		+ 31·46		+ 18·49	
V_a	− 19·49		− 20·90		− 25·69		− 26·90		− 28·75		− 29·37		− 29·42	
V_d	− 0·02		− 0·20		− 0·16		− 0·11		− 0·16		− 0·13		− 0·16	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 7·5		+ 8·1		+ 6·2		+ 11·2		− 2·8		+ 1·7		− 11·3	
H and *K*	+ 3·6		+ 6·7		+ 9·3		+ 8·8		− 1·1		− 2·6		+ 4·8	

MEASURES OF χ AURIGÆ—*Continued*

λ	6896		6919		6956		7135		7152		7175		7199	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	+28·0	1	+18·4	1	+ 3·6	½	...	...	...	...	...	...	...	...
3964·875	+13·2	¼	+ 9·9	¼	...	...	...	...	...	...	...	...	...	...
3968·625	+30·5	½	+28·9	¼	...	...	...	...	...	...	...	...	...	...
4009·417	+18·9	¼	...	...	...	...	...	...	...	...	...	...	...	...
4026·352	+34·0	¼	+18·3	½	+19·9	¼	...	...	...	...	−38·1	¼	−52·0	½
4101·890	+21·5	½	+17·7	½	+ 6·5	¼	...	...	...	...	...	...	...	...
4131·047	+21·0	¼	...	...	...	...	...	...	...	...	...	...	...	...
4143·928	+27·0	¼	+32·4	¼	...	...	...	...	...	...	−66·4	¼	−45·7	¼
4267·301	...	...	...	...	− 6·4	¼	...	...	...	...	−40·4	¼	...	...
4340·634	+19·0	½	+11·1	½	+11·3	½	−41·6	¼	...	...	−63·0	½	−50·0	¼
4388·100	+22·2	½	...	...	− 2·3	½	...	...	−44·3	½	−45·5	½	...	...
4471·676	+33·6	1	+19·3	1	0·0	½	−45·8	½	−47·0	1	−27·2	½	−41·5	½
4481·400	+17·5	½	+20·0	1	+ 5·0	¼	−33·7	¼	−54·8	½	−45·5	½	−58·6	½
Weighted mean	+ 24·05		+ 18·38		+ 4·28		− 41·72		− 48·27		− 46·12		− 50·00	
V_a	− 28·37		− 25·59		− 21·04		+ 19·95		+ 23·82		+ 27·48		+ 28·47	
V_d	− 0·16		− 0·22		− 0·28		+ 0·27		+ 0·25		+ 0·23		+ 0·16	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 4·8		− 6·8		− 17·3		− 21·8		− 24·5		− 18·7		− 21·6	
H and *K*	0·0		− 5·6		− 18·0		...		...		...		...	

MEASURES OF χ AURIGÆ—*Continued*

λ	7227		7264		7280		7316		7323		7345		7364	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	...	...	...	...	−32·6	½	−39·8	¼	−28·0	½	...	...	−23·1	½
3964·875	...	...	...	...	...	...	...	...	...	...	−28·6	½	...	...
4009·417	...	...	...	...	...	...	...	...	−48·0	¼	...	...	−36·7	¼
4026·352	−35·5	½	−32·9	½	−40·7	½	−52·0	½	−30·1	½	−25·2	½	−37·3	½
4101·890	...	...	−27·9	½	...	...	−55·7	¼	...	...	−32·5	½	−38·0	½
4121·016	...	...	...	...	...	...	...	...	...	...	...	...	−42·4	¼
4128·211	...	...	...	...	...	...	...	...	...	...	−42·7	¼	−21·3	¼
4131·047	...	...	...	...	...	...	...	...	...	...	−28·5	¼	−36·1	¼
4143·928	−53·9	½	...	...	−48·1	¼	−52·9	¼	−37·7	¼	−29·8	½	−38·5	¼
4267·301	−50·0	½	...	...	...	...	...	...	...	...	−20·2	¼	−33·9	¼
4340·634	−45·0	½	...	...	−25·9	½	−50·7	½	−33·9	½	−20·3	½	−30·4	½
4388·100	−44·3	1	−47·8	½	−56·0	½	−42·0	½	−35·1	½	−29·1	½	−40·8	½
4471·676	−46·4	1	−37·7	1	−35·2	1	−48·9	1	−30·5	1	−20·3	½	−31·5	1
4481·400	...	...	−61·1	½	−61·1	½	−61·1	¼	...	...	−30·6	½	...	...
Weighted mean	− 45·72		− 40·85		− 42·79		− 50·35		− 33·82		− 27·58		− 34·68	
V_a	+ 29·06		+ 29·23		+ 29·11		+ 28·34		+ 26·90		+ 25·57		+ 23·00	
V_d	+ 0·10		+ 0·13		+ 0·04		+ 0·05		+ 0·06		+ 0·08		− 0·07	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 16·8		− 11·8		− 13·9		− 22·2		− 7·1		− 2·2		− 12·2	
H and *K*	...		...		− 3·7		− 11·7		− 12·9		...		− 0·6	

MEASURES OF χ AURIGÆ—*Continued*

λ	7373		7384		7401		7415		7429		7440		7447	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel	Wt.	Vel.	Wt.
3933·825	−25·2	½	...	...	− 0·6	½	...	...	−12·8	¼	...	...	− 8·0	½
3964·875	− 8·2	½	...	...	...	...	...	...	−17·3	¼	...	...	...	...
3968·625	...	...	...	...	−10·7	½	...	...	...	...	...	...	+ 6·6	½
4026·352	...	...	−36·6	¼	−19·1	½	...	...	−17·8	½	...	...	− 1·3	½
4101·890	...	...	−29·4	¼	−12·1	½	...	...	− 5·1	½	...	...	−17·7	½
4143·928	−32·4	½	−45·0	¼	...	...	...	...	−26·1	¼	...	...	...	...
4267·301	...	...	...	...	−13·9	½	...	...	...	...	...	...	...	...
4340·634	−42·9	1	−53·0	¼	−30·0	1	−31·6	½	− 3·4	½	+11·3	½	− 7·9	½
4388·100	−37·0	½	−25·8	1	−31·5	½	−31·2	½	−28·1	¼	...	...	0·0	½
4471·676	−19·9	1	−29·2	1	−24·8	1	−32·3	½	− 6·8	1	− 7·4	½	− 8·7	½
4481·400	−31·3	½	−35·0	1	− 3·7	½	−28·2	½	...	...	−12·5	¼	...	...
Weighted mean	− 28·40		− 32·75		− 21·10		− 30·32		− 11·81		− 0·94		− 7·11	
V_s	+ 19·62		+ 18·53		+ 15·92		+ 13·76		+ 10·42		+ 7·41		+ 2·28	
V_d	+ 0·22		− 0·08		+ 0·10		+ 0·22		+ 0·05		+ 0·23		+ 0·04	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 9·8		− 14·6		− 5·3		− 16·6		− 1·4		+ 6·4		− 4·9	
H and *K*	− 6·6		...		+ 10·1		...		− 2·4		...		+ 1·5	

MEASURES OF χ AURIGÆ—*Continued*

λ	7454		7458		7475		7481		7494		7502		7504	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	− 0·8	½	− 0·8	½	+12·8	¼	+16·8	¼	+20·8	¼	+36·0	½	+29·6	½
3964·875	− 7·4	¼	+15·6	¼	......	......	......	......	......	......	......	......	+46·1	¼
3968·625	......	......	......	......	+19·9	½	......	......	+19·8	¼	+35·5	¼	+44·2	½
4009·417	......	......	+17·1	¼	......	......	......	......	......	......	......	......	......	......
4026·352	− 3·5	½	+17·0	½	+ 0·4	¼	+17·0	½	......	......	+29·2	½	+24·0	½
4101·890	−15·8	½	+ 8·4	½	+ 8·4	½	+14·9	½	+25·2	½	+37·3	½	+15·9	½
4121·016	......	......	......	......	......	......	......	......	+30·8	¼	......	......	......	......
4128·211	......	......	+15·2	¼	......	......	+23·5	¼	+10·5	¼	+18·1	½	+15·3	½
4131·047	......	......	+ 1·9	¼	......	......	......	......	......	......	+44·0	¼	+26·8	¼
4143·928	......	......	......	......	+12·6	½	+16·4	¼	+19·3	¼	......	......	+30·5	½
4267·301	+ 5·3	½	+ 9·6	¼	+24·6	¼	+28·9	½	+24·6	½	......	......	+40·6	½
4340·634	−16·4	½	− 3·4	1	+ 4·5	1	+13·1	1	+19·8	½	+39·0	½	+39·0	½
4388·100	− 3·5	½	+14·0	½	0·0	½	+ 3·5	½	+28·1	½	+38·6	½	+38·6	¼
4471·676	− 4·3	1	+16·8	1	+ 3·7	1	+ 7·4	1	+14·3	½	+46·0	½	+32·3	1
4481·400	......	......	+11·3	¼	+ 2·5	¼	+ 8·8	1	+25·0	½	+38·8	½	+35·1	1
Weighted mean	− 6·15		+ 10·15		+ 6·01		+ 12·98		+ 22·62		+ 35·87		+ 31·52	
V_a	− 2·85		− 6·97		− 11·76		− 14·71		− 20·81		− 22·72		− 24·94	
V_d	+ 0·07		+ 0·04		+ 0·19		0·00		+ 0·02		− 0·23		− 0·06	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 9·2		+ 3·0		− 5·8		− 2·0		+ 2·6		+ 12·6		+ 6·2	
H and *K*	− 3·9		− 8·0		+ 4·5		+ 1·8		+ 0·3		+ 12·6		+ 11·6	

MEASURES OF χ AURIGÆ—*Continued*

λ	7510		7512		7517		7527		7532		7536		7539	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	+30·4	1	+34·4	1	+32·0	½	+31·2	½	+27·2	½	+28·8	½	+32·8	½
3964·875	+31·3	¼	…	…	…	…	+29·6	¼	…	…	…	…	…	…
3968·625	+43·0	¼	…	…	+41·6	½	+41·3	¼	…	…	+38·0	½	+38·8	½
4009·417	…	…	…	…	+41·2	¼	+38·2	½	…	…	…	…	…	…
4026·352	+42·3	¼	+30·0	½	+35·3	½	+30·1	½	+45·3	½	+42·7	½	+31·4	½
4101·890	+45·7	½	+42·9	1	…	…	…	…	+33·6	½	+37·3	½	…	…
4128·211	…	…	…	…	+25·8	¼	…	…	…	…	…	…	+33·4	½
4131·047	…	…	…	…	+19·1	¼	…	…	…	…	…	…	+24·9	½
4143·928	+29·5	½	+31·9	½	+30·9	½	+19·8	½	…	…	…	…	+26·1	½
4267·301	…	…	…	…	+37·4	½	+24·6	½	+47·0	¼	…	…	+24·9	½
4340·634	+41·3	1	+25·4	½	…	…	+21·5	¼	+22·6	½	+25·4	½	…	…
4388·100	+32·8	½	…	…	+31·6	½	+25·8	½	+22·2	½	+28·1	½	+24·6	½
4471·676	+47·9	1	+42·9	1	+44·8	½	+36·9	½	+37·3	½	+51·6	½	+46·6	½
4481·400	+47·6	½	…	…	+30·7	½	…	…	+31·3	½	…	…	+32·6	½
Weighted mean	+ 41·20		+ 36·99		+ 34·76		+ 31·00		+ 34·00		+ 38·02		+ 30·57	
V_a	− 27·26		− 27·44		− 27·98		− 28·82		− 28·94		− 29·04		− 29·29	
V_d	− 0·22		+ 0·05		− 0·05		− 0·06		0·00		− 0·19		− 0·08	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 13·5		+ 9·4		+ 6·5		+ 1·8		+ 4·8		+ 8·5		+ 0·9	
H and *K*	…		+ 5·3		+ 8·5		+ 5·4		− 2·0		+ 3·9		+ 6·1	

MEASURES OF χ AURIGÆ—*Continued*

λ	7542		7549		7550		7558		7562		7571		7585	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	+40·0	½	+34·4	½	+36·0	½	+39·2	½	+40·0	½	+32·0	½	+37·6	½
3964·875	...	...	+42·8	¼	+42·8	¼	...	...	+49·3	¼	+49·3	¼	+39·5	¼
3968·625	...	...	+33·9	½	+35·1	½	...	...	+42·1	1	+40·2	½	+35·6	½
4009·417	...	...	+28·3	¼	...	...	...	...	+49·7	¼	...	...	...	...
4026·352	+54·9	¼	+34·0	½	+44·1	½	+34·4	½	+38·8	½	+51·5	½	+39·6	½
4101·890	+36·4	¼	+43·9	½	+48·0	½	+35·5	½	+39·2	½	+44·3	½	+37·3	½
4121·016	...	...	...	...	...	...	...	...	...	...	...	...	+38·4	¼
4128·211	...	...	+42·0	¼	+44·8	¼	...	...	...	...	...	...	+52·5	¼
4131·047	...	...	+47·8	½	...	...	...	...	+31·5	¼	...	...	+38·7	¼
4143·928	...	...	+39·2	½	+32·9	¼	+48·8	½	+48·8	¼	+35·3	¼	+30·4	½
4267·301	...	...	+51·3	¼	...	...	...	...	+55·6	¼	+52·4	¼	+37·4	½
4340·634	+44·1	½	+34·5	½	+35·1	½	+30·0	½	+36·4	½	+40·7	½	+28·3	½
4388·100	+25·7	½	+42·7	½	+23·4	¼	+25·8	½	+21·8	½	+39·2	½	+17·6	½
4471·676	+47·3	½	+48·5	1	+37·4	½	+52·2	1	+58·5	1	+45·4	½	+47·3	½
4481·400	...	...	+36·3	¼	+35·7	½	+29·4	½	+42·6	½	+43·2	¼	+42·6	½
Weighted mean	+ 40·69		+ 41·45		+ 38·84		+ 38·53		+ 43·73		+ 44·44		+ 36·52	
V_a	− 29·52		− 29·47		− 29·47		− 29·46		− 29·28		− 29·11		− 28·26	
V_d	− 0·11		− 0·22		− 0·25		− 0·25		− 0·13		− 0·24		− 0·18	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 10·8		+ 11·5		+ 8·8		+ 8·5		+ 14·0		+ 14·8		+ 7·8	
H and *K*	+ 10·1		+ 4·2		+ 5·5		+ 9·2		+ 11·7		+ 6·5		+ 7·8	

MEASURES OF χ AURIGÆ—*Concluded*

λ	7594		7601		7624		7632							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	+40·0	½	+38·4	1	+20·0	½	+32·8	¼						
3964·875	+46·9	¼	+48·6	½										
3968·625	+24·0	½	+45·4	½			+40·0	¼						
4009·417	+33·5	¼												
4026·352	+31·0	1	+55·8	1	+32·7	1	+50·1	¼						
4101·890	+28·0	½	+55·0	½	+28·0	½	+46·6	½						
4121·016	+36·5	¼			+23·5	¼	+52·6	¼						
4128·211	+24·8	¼	+31·5	½	+32·5	¼	+38·2	¼						
4131·047	+35·4	¼	+36·3	½			+36·3	¼						
4143·928	+34·8	¼	+15·0	½	+32·4	¼	+49·8	¼						
4267·301	+56·7	¼			+26·2	¼								
4340·634	+29·4	1	+55·4	1	+32·8	1	+28·8	½						
4388·100	+51·5	1	+45·6	1			+49·2	½						
4471·676	+38·6	1			+36·1	1	+54·7	½						
4481·400	+42·6	¼	+30·0	½	+35·1	1	+45·1	½						
Weighted mean	+ 37·27		+ 44·16		+ 28·97		+ 45·05							
V_e	− 27·80		− 27·22		− 19·15		− 18·40							
V_d	− 0·23		− 0·19		− 0·28		− 0·28							
Curv.	− 0·28		− 0·28		− 0·28		− 0·28							
Radial Velocity	+ 9·0		+ 16·5		+ 9·3		+ 26·1							
H and *K*	+ 3·7		+ 13·0		+ 0·3		+ 17·4							

The period is remarkably long for an early type star, and it so happens that the observations taken at the Yerkes Observatory fall almost at the top of the curve, so near this point, in fact, that in the preliminary elements it was impossible to decide on which branch of the curve they should lie. For this reason, and also because there is generally a systematic difference between radial velocities obtained at two observatories, the period was determined from the Ottawa observations alone. As it turned out, the inclusion of the Yerkes Observatory plates would have yielded practically the same result, for the final orbit gives a mean residual for their plates of +3.1 kilometres, which is just about the difference usually found between measures made by the two observatories. Seventeen normal places were formed as given. It is unfortunate that the negative minimum is not more strongly determined, but the lack of observations is due to the star and sun being in conjunction at that time. If the star were followed for another revolution this defect could be remedied. In order to determine the period accurately, the star should be observed at some epoch in the future which can be so chosen as to define the negative minimum as well.

The preliminary elements chosen follow the normal places and the successive steps in the least-square solution are recorded.

NORMAL PLACES

No.	Julian Day	Phase from Preliminary T	Velocity	Weight	O–C Preliminary	O–C Final
1	2,420,077·8	108·8	−19·3	·3	+1·2	+1·1
2	129·1	160·1	−16·1	·3	−3·8	−3·1
3	185·2	216·2	− 2·3	·4	+0·6	+1·4
4	413·8	444·8	+19·2	·8	+0·9	+1·3
5	467·9	498·9	+14·0	·6	−2·3	−1·6
6	492·1	523·1	+12·5	·8	−1·4	−0·5
7	534·4	565·4	+ 8·3	·4	+1·6	+2·4
8	571·6	602·6	− 4·3	·4	−1·6	−1·3
9	609·0	640·0	−12·1	·2	+1·3	−0·6
10	730·3	101·3	−21·6	·4	−0·1	−0·9
11	761·1	132·1	−16·2	·4	+0·8	+0·4
12	800·4	171·4	− 9·2	·6	+1·2	+1·0
13	839·9	210·9	− 3·5	·4	+0·3	+0·2
14	879·4	250·4	+ 2·1	·5	−0·2	−0·2
15	920·7	291·7	+ 6·9	·9	−0·9	−1·0
16	948·1	319·1	+11·4	·8	+0·5	+0·4
17	987·2	358·2	+14·9	·2	+0·2	+0·3

PRELIMINARY ELEMENTS

P = 660 days
T = J. D. 2,420,629
$\omega = 135°$
$e = 0.20$
$K = 21.5$
$\gamma = -0.16$
$\mu = 0°.545455$

OBSERVATION EQUATIONS

	x	y	z	p	q	r	−n	Weight
1......	1·000	−·946	+ ·531	+ ·452	− ·629	−·347	−1·21	0·3
2......	1·000	−·565	+1·007	+ ·765	− ·787	−·394	+3·78	0·3
3......	1·000	−·128	+ ·639	+ ·859	− ·734	−·326	−0·62	0·4
4......	1·000	+·859	− ·714	− ·135	− ·004	−·001	−0·90	0·8
5......	1·000	+·769	+·077	− ·557	+ ·360	+·058	+2·34	0·6
6......	1·000	+·654	+ ·528	− ·747	+ ·574	+·079	+1·39	0·8
7......	1·000	+·319	+1·105	−1·029	+1·000	+·095	−1·61	0·4
8......	1·000	−·120	+ ·901	−1·141	+1·295	+·074	+1·55	0·4
9......	1·000	−·616	− ·133	−1·021	+1·250	+·025	−1·31	0·2
10......	1·000	−·992	+ ·381	+ ·384	− ·574	+·058	+0·10	0·4
11......	1·000	−·783	+ ·869	+ ·625	− ·738	+·097	−0·80	0·4
12......	1·000	−·475	+ ·989	+ ·801	− ·787	+·135	−1·18	0·6
13......	1·000	−·167	+ ·701	+ ·859	− ·743	+·157	−0·26	0·4
14......	1·000	+·114	+·217	+ ·826	− ·661	+·165	+0·18	0·5
15......	1·000	+·370	− ·308	+ ·719	− ·559	+·163	+0·89	0·9
16......	1·000	+·514	− ·606	+ ·614	− ·485	+·155	−0·52	0·8
17......	1·000	+·693	− ·896	+ ·410	− ·355	+·127	−0·17	0·2

Where
$$x = d\gamma$$
$$y = dK$$
$$z = Kde$$
$$p = Kd\omega$$
$$q = \frac{K\mu}{(1-e^2)^{\frac{3}{2}}}\,dT$$
$$r = \frac{1000\ K}{(1-e^2)^{\frac{3}{2}}}\,d\mu$$

NORMAL EQUATIONS

$$\begin{array}{rrrrrrr}
+8\cdot400x & +1\cdot001y & +1\cdot931z & +1\cdot459p & -1\cdot465q & +0\cdot402r & +1\cdot382=0 \\
 & +3\cdot003y & -1\cdot638z & -1\cdot035p & +0\cdot986q & +0\cdot297r & +1\cdot433=0 \\
 & & +3\cdot708z & -0\cdot070p & -0\cdot026q & -0\cdot111r & +0\cdot903=0 \\
 & & & +4\cdot367p & -4\cdot050q & +0\cdot017r & -1\cdot267=0 \\
 & & & & +3\cdot890q & +0\cdot028r & +1\cdot052=0 \\
 & & & & & +0\cdot223r & -0\cdot153=0
\end{array}$$

Whence

$x = +0\cdot013$	or	$d\gamma$	$= +0\cdot01$ km.
$y = -0\cdot969$		dK	$= -0\cdot97$ km.
$z = -0\cdot625$		de	$= -0\cdot029$
$p = +0\cdot197$		$d\omega$	$= +0^\circ\cdot52$
$q = +0\cdot169$		dT	$= +0\cdot78$ day
$r = +1\cdot606$		$d\mu$	$= +0^\circ\cdot004025$

FINAL ELEMENTS

$$P = 655 \cdot 16 \pm 5 \cdot 26 \text{ days}$$
$$T = \text{J. D. } 2{,}420{,}629 \cdot 78 \pm 9 \cdot 56 \text{ days}$$
$$\omega = 135^\circ \cdot 52 \pm 5^\circ \cdot 2$$
$$e = 0 \cdot 171 \pm 0 \cdot 026$$
$$K = 20 \cdot 53 \text{ km.} \pm 0 \cdot 57 \text{ km.}$$
$$\gamma = -0 \cdot 15 \text{ km.} \pm 0 \cdot 35 \text{ km.}$$
$$a \sin i = 182{,}300{,}000 \text{ km.}$$
$$\frac{m_1^3 \sin^3 i}{(m + m_1)^2} = 0 \cdot 56 \odot$$

THIRD BODY

It will be noticed that the binary character was announced from three plates, which the orbit shows to fall near the epoch of positive maximum (cf. radial velocity curve)*. In the interval covered by these plates the variation should be small and the velocities increasing. One is forced to conclude that there is another period superimposed upon the one found, or else that the announced variation means nothing. The spectrograms have been remeasured at the Yerkes Observatory, and Professor Frost finds no reason to doubt that the range indicated by the velocities is real.

We have been unable to find a period for this variation. Several periods would harmonize some of the larger residuals and so reduce the sum Σpv^2 a little, but the fact that there are several which look equally good (or bad) is enough to render one suspicious of the reality of any. No period found would satisfy the residuals from the main orbit well enough to warrant its adoption.

Considering the elements of the system as published, the probable error of a single observation is 3·5 kilometres. This is larger than we usually find for good line stars by about 20 per cent.

In the *Astrophysical Journal*, March, 1915, Dr. Schlesinger published a method for determining the periodicity in a series of observations from a consideration of the distribution of the observed velocities. Thus, for example, if we are dealing with a circular orbit, more velocities should be found near positive maximum and negative minimum than near the γ line. If the residuals are due entirely to error of observation, the velocities around the γ line will be most numerous. Curves are published giving the expected distribution of the velocities for orbits of various forms. In these curves some allowance has been made for the effect of probable error of measurement upon the results.

Some time previous to the publication of this article, the writer tried to make use of the same method in getting a period for the binary 12 Lacertæ. In this case the velocities were distributed very much as one would expect if the observed range were due to error of measurement alone and yet, since the total observed range was over sixty kilometres, there could be no doubt of the binary nature of the star. The conclusion

*The normal place from the observations taken at the Yerkes Observatory is indicated by a circle and cross.

was that the expected distribution was affected very much by errors of measurement. In applying the method to the present star I have taken some care to find out just what distribution of velocities we should expect when both factors are taken into account.

Let us suppose that we are dealing with a circular orbit whose range is from plus ten kilometres to minus ten kilometres, and that the probable error of measurement is r. Let the velocities, if there were zero error of measurement, which would lie between the limits plus ten to plus nine be denoted by a, plus nine to plus eight be denoted by b, plus eight to plus six by c, ..., plus two to zero by f. Let those from zero to minus two be denoted by f', and so on till those between minus nine and minus ten are denoted by a'. Secondly, let us suppose the range in the observations is due to error of measurement alone, and let the velocities which would lie between the limits zero to plus two be denoted by *1*, between the limits plus two to plus four by *2*, etc. to infinity. To distinguish the negative from the positive add the subscript minus. Thus 1_{-} indicates the velocities lying between minus two and zero.

The numbers a, b, c, are easily computed analytically or graphically. The graphical method has the advantage that it can be applied to any radial velocity curve, while the analytic expression for a, b, c, for other than circular orbits is very cumbersome. The values of *1*, *2*, *3*,........ can be readily computed for any assumed probable error.

Now let all the velocities a, b, c, etc., be operated on by errors of measurement, which errors are distributed as indicated by *1*, *2*, *3*, etc. The product of a and *1* (which may be written a_1) will yield velocities lying between $+9$ and $+12$, and if we have chosen our interval small enough we may regard the velocities as distributed uniformly within this interval, so that $\frac{2}{3}a_1$ will be the number lying between $+12$ and $+10$. $\frac{1}{3}a_2$ will also lie between the same limits, and if we select all these combinations we will obtain the following series as giving the number of velocities between $+12$ and $+10$.

$$\begin{aligned} &\tfrac{2}{3}a_1 + \tfrac{1}{3}a_2 + \tfrac{1}{3}b_1 + \tfrac{2}{3}b_2 + \tfrac{1}{2}c_2 + \tfrac{1}{2}c_3 \\ &+ \tfrac{1}{2}d_3 + \tfrac{1}{2}d_4 + \tfrac{1}{2}e_4 + \tfrac{1}{2}e_5 + \tfrac{1}{2}f_5 + \tfrac{1}{2}f_6 \\ &+ \tfrac{1}{2}f'_6 + \tfrac{1}{2}f'_7 + \tfrac{1}{2}e'_7 + \tfrac{1}{2}e'_8 + \tfrac{1}{2}d'_8 + \tfrac{1}{2}d'_9 \\ &+ \tfrac{1}{2}c'_9 + \tfrac{1}{2}c'_{10} + \tfrac{2}{3}b'_{10} + \tfrac{1}{3}b'_{11} + \tfrac{2}{3}a'_{11} + \tfrac{1}{3}a'_{10} \end{aligned}$$

To obtain the velocities lying between $+10$ to $+8$ all that it is necessary to do is to depress the subscripts by one, $\frac{2}{3}a_1$ becomes $\frac{2}{3}a_{1-}$, $\frac{1}{3}a_2$ becomes $\frac{1}{3}a_1$, etc. To obtain the velocities lying between $+14$ and $+12$ increase the subscripts by one. The number of velocities lying between limits x and $x+2$ are obtained by increasing the subscripts $\frac{x-10}{2}$.

These series have been evaluated for $r = 2, 4, 6\cdot\dot{6}6, 10$ kilometres, *i.e.*, for the ratios of probable error of measurement to total range equal $\frac{1}{10}$, $\frac{1}{5}$, $\frac{1}{3}$, $\frac{1}{2}$. The results are tabulated below and represented graphically in fig. 1.

Velocities in km.	r=2 km.	r=4 km.	r=6·6 km.	r=10 km.
From + 0 to + 2	·0680	·0753	·0637	·0479
" + 2 to + 4	·0795	·0748	·0623	·0474
" + 4 to + 6	·0833	·0723	·0591	·0461
" + 6 to + 8	·0878	·0674	·0554	·0441
" + 8 to +10	·0793	·0604	·0503	·0415
" +10 to +12	·0571	·0495	·0442	·0387
" +12 to +14	·0295	·0380	·0384	·0356
" +14 to +16	·0104	·0266	·0318	·0321
" +16 to +18	·0025	·0173	·0258	·0284
" +18 to +20	·0004	·0099	·0201	·0249
" +20 to +22		·0053	·0150	·0215
" +22 to +24		·0024	·0111	·0185
" +24 to +26		·0009	·0079	·0153
" +26 to +28		·0002	·0052	·0124
" +28 to +30		·0001	·0031	·0100
" +30 to +32			·0019	·0079
" +32 to +34			·0010	·0061
Sum	·4978	·5004	·4963	·4784

In the tabulated results the numbers are given to four decimal places, and as each was obtained by the summation of several factors, each of which was only computed to four places, the last figure is not in general correct. The sum of the columns given at the bottom if extended to infinity should total one-half, so that the addition of the columns serves as a partial check on the work.

In the curves the abscissae are kilometres, any point plus x indicates velocities lying between plus $x-1$ and plus $x+1$ and the corresponding ordinate shows what fraction of all the velocities will lie between these limits. It will be noticed that curves for the ratios $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{5}$ are very similar to error curves.

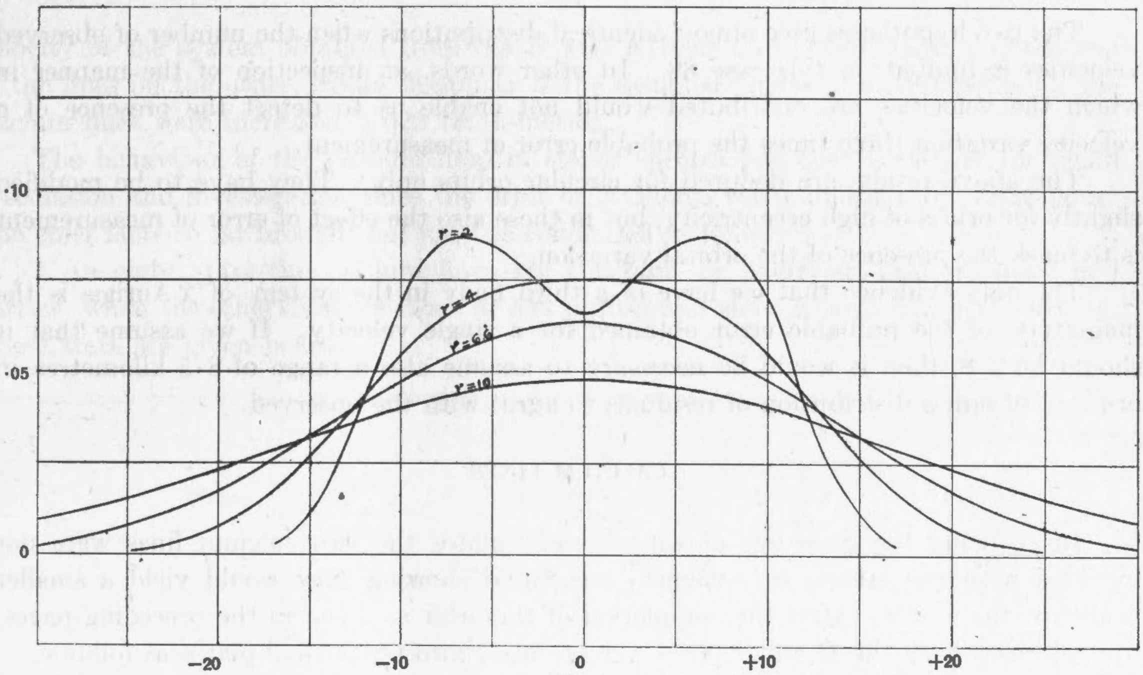


Fig. 1

Suppose now we are working with such a binary as the one indicated, namely, a range plus ten to minus ten, and error of measurement *r* kilometres. Let us suppose, further, that we are unable to get a period, and treat the residuals as errors, how much in excess of the true value of *r* would the value we obtain be? The results we have tabulated for the distribution of the velocities enable us to compute this with a fair degree of accuracy, and we obtain that, if *r* equal 2 kilometres the computed *r* will be 5·1, if *r* equal 4 kilometres the computed *r* will be 6·1, and if *r* equal 6·6 kilometres the computed *r* will be 8·2. The computation becomes a little uncertain for *r* equal 10 on account of some velocities lying beyond the computed values.

To apply the results to χ Aurigæ, we have computed the distribution of the velocities on two bases. In the first the residuals are supposed to be due to error of measurement alone, in the second they are supposed to be due to a probable error of measurement 2·84 kilometres, combined with a binary whose eccentricity is zero and range 8·52 kilometres. In the table below, the first line gives the distribution of the observed residuals, the second, the computed distribution on hypothesis one, and the third the computed distribution on hypothesis two.

	km. 0–1	km. 1–2	km. 2–3	km. 3–4	km. 4–5	km. 5–6	km. 6–8	km. 8–10	km. 10–∞
1	14	15	11	14	6	4	11	7	6
2	13	13	12	11	9	8	11	5	6
3	13	13	12	11	9	8	11	6	5

The two hypotheses give almost identical distributions when the number of observed velocities is limited, in this case 88. In other words, an inspection of the manner in which the velocities are distributed would not enable us to detect the presence of a velocity variation three times the probable error of measurement.

The above results are deduced for circular orbits only. They have to be modified slightly for orbits of high eccentricity, but in these also the effect of error of measurement is to mask the presence of the orbital variation.

The only evidence that we have of a third body in the system of χ Aurigæ is the magnitude of the probable error obtained for a single velocity. If we assume that it should be 2·8, then it would be necessary to assume also a range of 8·5 kilometres in order to obtain a distribution of residuals to agree with the observed.

CALCIUM LINES

In reducing the measures of the different plates the two calcium lines were not included with the others, for evidence was found showing they would yield a smaller range for the curve. After the completion of the orbit as given in the preceding pages, the velocities from the *H* and *K* lines were grouped into ten normal places as follows.

NORMAL PLACES FOR *H* AND *K* LINES

	Julian Day	Phase from Final *T*	Velocity	Weight	O–C
1	2,420,104·4	129·8	− 9·5	1·0	−2·3
2	151·3	176·7	− 0·8	0·8	+2·5
3	202·4	227·8	+ 0·5	0·9	−0·4
4	249·9	275·3	+ 7·6	1·0	+3·2
5	277·0	302·5	+ 5·2	1·3	−0·9
6	302·9	328·3	+10·3	1·2	+2·8
7	411·8	437·2	+ 9·9	1·3	−0·6
8	473·4	498·8	+ 7·2	1·4	−1·9
9	502·1	527·5	+ 7·2	1·4	−0·1
10	571·2	596·6	+ 0·6	1·5	+0·7

Preliminary elements to satisfy these places were selected, the period, eccentricity and ω were taken as previously found for the other lines. A solution was carried through for γ and K with the result,

$$\gamma = +\ 1{\cdot}5 \text{ km. } \pm 0{\cdot}46$$
$$K = 10{\cdot}47 \text{ km. } \pm 0{\cdot}85$$

The radial velocity curve for the *H* and *K* lines is given on the same diagram as that for the other lines and is drawn with the finer line. The difference between the velocity of the system obtained from the *H* and *K* lines on the one hand, and the rest of the lines on the other, would disappear if the assumed values of wave-lengths for the calcium lines were increased 0·022 tenth-metres.

The behaviour of the calcium lines in stellar spectra has been a subject for much speculation and investigation since the orbit of δ Orionis was published by Hartmann.[1] The chief facts so far brought out may be condensed as follows:—

1. In eight stars the calcium lines are constant, or nearly so, and are sharp and narrow, while the other lines are more or less diffuse and show a large range in velocity. These stars are given below.

Name	R.A. 1900	Type	Range of Broad Lines	Remarks
	h m		km.	
o Persei	3 38·0	B1	224	Lick Obs. Bull. 181
η Orionis	5 19·4	B1	290	" "
ψ Orionis	5 21·6	B2	288	" "
δ Orionis	5 26·9	B	216	" "
VV Orionis	5 28·5	B2	264	P.A.O., Vol. III, No. 21
θ_2 Orionis	5 30·5	B1	220	Lick Obs. Bull. 181
β Scorpii	15 59·6	B1	251	P.A.O., Vol. II, No. 14
Boss 6142	23 51·0	Oep	230	D.O. (unpublished)

All the stars in this list are of type B2 or earlier, and, moreover, if we form a list of all such stars whose orbits have been determined and the *K* line measured, we find only one, ν Orionis, showing a large range and not included above. Future orbits may add other exceptions.

2. In several stars, the calcium lines are known to vary differently from the other lines and in four cases, orbits have been determined from the *H* and *K* lines, *i.e.*, for ξ Persei[2], type Oe5; 9 Camelopardalis[3], type B; χ Aurigæ, type B1; 12 Lacertæ[4], type Oe5. In the last two the amplitude is probably about one-half as large for the calcium lines as for the others. There can be little doubt but that future investigation will reveal all gradations from those in which the *H* and *K* lines are constant to those where they have the same oscillation as the other lines.

3. In three stars the calcium lines are sharp and narrow and are shifted about one-half an Ångström unit to the violet. These stars are,—ξ Persei, type Oe5; ϕ_1 Orionis[5], type B; ρ Leonis[6], type B. There is evidence in these cases that it is the hydrogen

[1] Ap. J., Vol. XIX, p. 268, 1904.
[2] Dom. Obs. Pub., Vol. I, p. 355.
[3] Ap. J., Vol. XXXVII, p. 1, 1913.
[4] R.A.S.C.Jr., November, 1915.
[5] Ap. J., Vol. XXX, p. 63, 1909.
[6] Dom. Obs. Pub., Vol. 1, p. 337.

and helium lines that are shifted to the red and that the calcium lines may be in their normal positions.

In ξ Persei, the hydrogen and helium lines are broad and no orbit has been determined from them, although they seem to show a large range. The mean velocity is about plus sixty-five kilometres. An orbit has been determined from the *H* and *K* lines, and the velocity of the system is plus fifteen kilometres. The component of the solar motion away from this star is about plus six kilometres, so that unless the star has an abnormally high velocity for an early B-type star we must regard the *K* lines as giving the true velocity of the star.

In the case of ϕ_1 Orionis, no orbit has been published, but if we take the mean of the velocities as representing final values, the calcium lines give plus nineteen, the hydrogen and helium lines plus forty, as compared with a computed velocity from the solar motion plus fifteen. Here again it is the velocity from the *H* and *K* lines that seems the most probable.

No orbit has been published for ρ Leonis, but the mean velocities are, for the calcium lines plus ten, for the other lines plus forty-three, for the solar motion plus five.

4. In several stars (κ Cassiopeiæ[7], type B; 9 Camelopardalis, type B; ε Orionis[8], type B), the calcium lines are sharp and the other lines diffuse, but there does not seem to be much difference between the mean velocities as derived from the two sets of lines. The difference between these stars and those in 2 is only one of degree.

5. In many stars of early B-type, all the lines are very diffuse and in some cases the spectrum is almost continuous, so that little can be said concerning the behaviour of the calcium. α Virginis and δ Scorpii are representative.

6. There seems to be no exception to the rule, that when the calcium lines are sharp and narrow and the other lines broad, the star exhibits a variable radial velocity.

Three theories have been advanced to explain the observations. In the first, the calcium lines are supposed to be due to masses of cooler gas between the observer and the binary. In the second, the gas is supposed to surround the star or stars, and in the third, the phenomena are ascribed to anomalous dispersion.

The first hypothesis accounts for the sharp and narrow character of the *H* and *K* lines in class 1 and the fact that they yield constant velocity. Why should the calcium clouds always lie in front of a star of type B2 or earlier? We have examined several later B-type stars without finding anywhere *H* and *K* are stationary. There may be some stars later than B2 discovered which will show the effect, but the phenomenon seems to be one connected with early spectral type. In all cases in class 1 the velocities yielded by the calcium lines are very near the velocity of the system. This fact, however, does not argue strongly either against or for the first hypothesis on account of the very low velocities of the early B-type stars. The stars given under 3 require an explanation for the hydrogen and helium lines rather than for the calcium. The phenomenon is too complex to be accounted for by an hypothesis which allows so little latitude for adjustment.

[7]Unpublished results (Harper).
[8]Ap. J., Vol. XXIX, p. 235, 1908.

The second hypothesis may be presented as follows:—

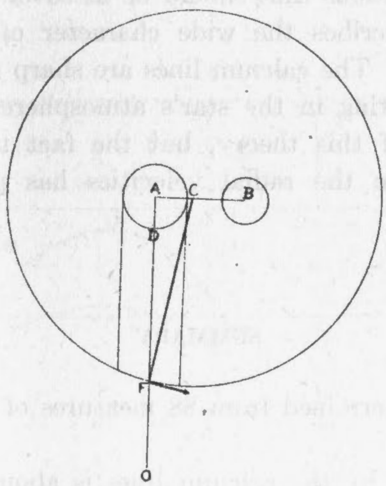


Fig. 2

Let A and B (fig. 2) be two stars or the two nuclei of a binary, and let the gases be condensed about these. It is known that calcium occurs at very high levels in the sun, and let us suppose that the equidensity layers in the calcium vapour about the two stars are nearly spheres. The calcium cloud will rotate about the common centre of gravity of the two stars in the same period as they revolve about each other. If A is the primary star and only one set of lines is observed on the plate, we need concern ourselves only with the light from A. The light from the photosphere gives the continuous spectrum, and as it passes through the cooler gases, hydrogen, helium and calcium, has lines from these elements absorbed. The absorption of the calcium takes place where the element is very rare, which accounts for the narrow character exhibited by these lines. The absorption of helium and hydrogen must be supposed to take place at a much lower level. Assume that it is permissible to speak of effective levels at which this absorption occurs, at a height D for the hydrogen and helium and at a height F for the calcium. At the time when the primary is moving toward us with the greatest velocity, the points at which the calcium absorption is taking place are rotating then as always about the point C and so are moving nearly across the line of sight. Moreover, the different points are all moving at about the same rate toward the observer, thus maintaining the narrow character of the lines. The points at which the hydrogen and helium absorption occurs, exhibit a wide range in velocity and give the wide character of the lines and the high range if the inclination is nearly zero. If the inclination is nearer to ninety degrees, the hydrogen and helium lines would be sharper and give a smaller range. This fits the case of 12 Lacertæ and χ Aurigæ. There are doubtless other factors not understood which may contribute to the width of the lines observed in other cases. If the calcium cloud were extensive enough the calcium lines would remain nearly stationary, at least the amplitude would be small enough to be masked by errors of measurement. As the cloud condensed, the amplitude observed in the *H* and *K* lines would increase, the exact range depending on the degree of condensation of the calcium.

This theory is capable of considerable adjustment[9] to meet varying demands, and suggests future types of variations that should be discovered.

The third hypothesis ascribes the wide character of the lines in these stars to anomalous dispersion effects. The calcium lines are sharp and narrow, due to the small traces of these elements existing in the star's atmosphere. It is not intended to pass on the merits or demerits of this theory, but the fact that it does not satisfactorily account for the periodicity in the radial velocities has prevented its receiving wide acceptance.

[9] Ap. J. Vol. XXXVII, p. 1, 1913.

SUMMARY

1. An orbit has been determined from 88 measures of radial velocity of χ Aurigæ.

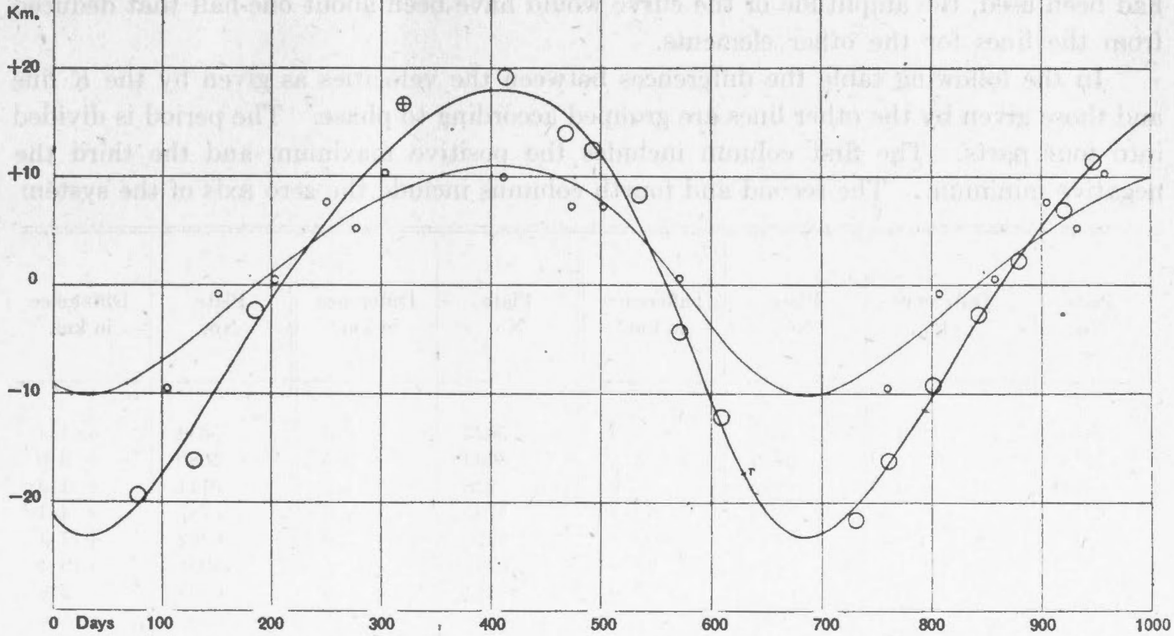
2. The amplitude shown by the calcium lines is about one-half that for the other lines of the spectrum.

3. An analysis of the different cases so far known where the calcium lines behave differently from the other lines shows that the phenomenon is one of type, and is best explained by the presence of calcium in a cloud surrounding the binary. The absorption of calcium takes place at a much higher level than that of the other elements.

4. The residuals given from the simple elliptic orbit were examined to ascertain if there might be a third body present. No secondary period was found, but the star should be observed with higher dispersion to test this point further.

5. The method of detecting periodicity in a set of observations from a consideration of the distribution of the velocities was tested. The value of this method is greatly interfered with by the effects of errors of measurement. If the ratio of error of measurement to range in the binary is as great as one-fifth, the resulting distribution of velocities is very much the same as would result from errors alone. If the ratio is as large as one-third, the distribution is almost identical. It is in these very cases that the method is most likely to be needed.

Dominion Observatory
Ottawa
June, 1916.



Radial Velocity Curves of χ Aurigæ

NOTE ON THE SPECTROSCOPIC BINARY 12 LACERTÆ

BY REYNOLD K. YOUNG, Ph.D.

The elements of this binary were published in the *Publications of the Dominion Observatory*, Vol. III, No. 3. An examination of the velocities given, shows the *K* line to have a smaller range than the other lines in the spectrum. If the calcium lines alone had been used, the amplitude of the curve would have been about one-half that deduced from the lines for the other elements.

In the following table the differences between the velocities as given by the *K* line and those given by the other lines are grouped according to phase. The period is divided into four parts. The first column includes the positive maximum and the third the negative minimum. The second and fourth columns include the zero axis of the system

Plate No.	Difference in km.	Plate No.	Difference in km.	Plate No.	Difference in km.	Plate No.	Difference in km.
5670	−12·0	5642	− 4·4	5623	+ 7·3	5630	+ 1·4
5735	−22·5	5720	+ 5·5	5692	+ 7·5	5680	+ 3·0
6244	− 3·0	5800	+ 6·9	5728	+ 5·7	5711	+ 1·3
6276	− 0·9	6198	+12·4	5792	+ 8·9	5787	− 4·1
6328	− 3·9	6335	+13·7	6270	+ 7·9	6262	+17·1
6369	+ 5·3	6349	−16·2	6281	+ 1·8	6291	+19·4
6409	− 9·9	6504	− 2·9	6342	+ 8·6	6308	− 2·6
6426	− 4·2	6992	− 2·0	6531	+ 6·1	6356	+11·0
6497	− 2·4	6998	+ 3·8	6542	− 4·1	6454	− 5·4
6521	+12·6	7033	− 9·4	7001	+14·8	7023	− 8·1
6557	+ 0·4	7043	+11·9	7020	+14·2	7178	+ 0·3
7026	− 1·9	7183	+ 9·9	7177	+22·5	7210	+16·0
7176	−13·3	7229	− 4·2	7214	+16·9	7244	− 4·4
7182	+ 1·2			7243	+ 5·2		
7201	−12·2			7251	+ 9·9		
7211	− 9·8			7266	+ 6·7		
7249	− 2·3			7270	+15·0		
7268	+ 4·1			7293	− 2·2		
7302	− 2·5			7300	+10·0		
7310	−16·8			7313	+28·4		
7314	−11·0						
Mean	− 5·2	Mean	+ 1·9	Mean	+ 9·7	Mean	+ 3·5

The weighted mean of all the residuals is positive, due to the value of the wave-length of *K* used. If we remove this effect, the resulting means for columns 1, 2, 3, 4 would read −7·3 km., −0·2 km., +7·6 km., +1·4 km. The semi-amplitude of the velocity curve as found for all the lines was 16·92 km. The amplitude for the *K* line would be about 7·5 km. less.

Dominion Observatory
Ottawa
May, 1916.

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 2

MEASURES OF RADIAL VELOCITY OF BOSS 4826, 7 VIRGINIS, BOSS 4721, 59 HERCULIS AND μ VIRGINIS

BY J. B. CANNON, M.A.

MEASURES OF RADIAL VELOCITY OF BOSS 4826

The following measures were made of this star, ($\alpha = 18^h\ 57^m{\cdot}8$, $\delta = 26°\ 10'$). The range is small, probably not greater than might be expected as the probable error in measurement. The mean of the measures is probably very close to the radial velocity of the star.

The first table gives a list of the lines measured.

LINES MEASURED

Wave-length	Element	Wave-length	Element
4572·156	*Ti*	4340·634	*H*
4549·766	*Fe*	4315·178	*Fe-Ti*
4415·301	*Fe*	4289·915	*Cr-Ti*
4404·927	*Fe*		

OBSERVATIONS

Plate	Date	Velocity
7045	1915, June 2·760	−28·4 km. per sec.
7703	1916, " 22·712	−32·4 "
7713	" 30·604	−33·3 "
7718	July 5·792	−31·5 "
7729	" 13·636	−28·8 "
7758	" 24·818	−32·6 "
	Mean =	−31·2 km. per sec.

MEASURES OF BOSS 4826

λ	7045		7703		7713		7718		7729		7758			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572·156	−28·35	¼	−49·55	½	−40·82	¼	−30·75	¼	−48·18	¼	−28·51	½	.....	.....
4549·766	−28·11	¼	−39·32	¼	−21·68	¼	−25·60	¼	−17·64	¼	−28·72	¼	.....	.....
4415·301	−42·22	¼	.....	.....	.....	.....	−20·48	¼	.....	.....	.....	.....	.....	.....
4404·927	.....	.....	−30·58	¼	−37·28	½	−32·82	¼	−15·12	¼	.....	.....	.....	.....
4340·634	.....	.....	−43·80	¼	−37·12	¼	−31·16	¼	.....	.....	.....	.....	.....	.....
4315·178	−62·39	¼	−36·18	½	−39·52	½	−44·65	½	−33·12	¼	.....	.....	.....	.....
4289·915	.....	.....	−30·11	½	−43·32	¼	−36·46	¼	.....	.....	.....	.....	.....	.....
Weighted mean	− 39·93		− 38·37		− 37·06		− 33·32		− 28·51		− 28·58			
V_a	+ 11·73		+ 6·20		+ 3·86		+ 2·29		− ·12		− 3·55			
V_d	+ ·08		+ ·05		+ ·21		− ·14		+ ·10		− ·23			
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28			
Radial Velocity	− 28·4		− 32·4		− 33·3		− 31·5		− 28·8		− 32·6			

Dominion Observatory
Ottawa
December, 1916.

MEASURES OF RADIAL VELOCITY OF 7 VIRGINIS

BY J. B. CANNON, M.A.

Six plates of 7 Virginis ($\alpha = 11^h\ 55^m\cdot 3$, $\delta = +4°\ 08'$) were taken in the years 1915 and 1916. The measures give a range of 16 km. which is not enough to declare it a spectroscopic binary, considering the number and character of the lines measured. The star is of spectral type A, the lines measured are λλ 4549, 4481, H_γ, H_δ and K.

The measures follow :—

Plate	Date	Julian Day	Velocity
6979	1915, May 10·628	2,420,628·628	+ 5·2 km. per sec.
6994	" 14·621	632·621	− 3·1 "
7531	1916, Feb. 29·785	923·785	+ 3·1 "
7607	April 10·589	964·589	−11·8 "
7623	" 28·559	982·559	+ 4·2 "
7686	June 5·646	2,421,020·646	− 0·5 "
		Mean =	− 0·5 km. per sec.

MEASURES OF 7 VIRGINIS

λ	6979		6994		7531		7607		7623		7686			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	+15·81	¼	......	...	......	...	......	...	......	...	+27·70	¼	......	...
4481·400	+19·58	¼	+20·70	½	− 8·51	½	+ 0·25	½	+42·25	½	+39·40	½	......	...
4340·634	+30·20	½	+25·55	1	− 8·37	½	− 0·56	½	+12·50	½	+26·02	¼	......	...
4101·890	......	...	+10·84	¼	......	...	+ 5·05	¼	......	...	......	...	......	...
3970·177	......	...	......	...	......	...	−10·12	¼	......	...	......	...	......	...
3933·825	+34·19	½	+19·87	½	− 0·32	½	+ 2·07	½	+15·66	½	+10·41	¼	......	...
Weighted mean	+ 28·56		+ 21·58		− 5·73		− 0·20		+ 23·47		+ 28·58			
V_a	− 22·96		− 24·24		+ 9·12		− 11·42		− 19·07		− 28·57			
V_d	− ·10		− ·12		− ·02		+ ·14		+ ·09		− ·25			
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28			
Radial Velocity	+ 5·2		− 3·1		+ 3·1		− 11·8		+ 4·2		− 0·5			

Dominion Observatory
Ottawa
December, 1916.

MEASURES OF RADIAL VELOCITY OF BOSS 4721

BY J. B. CANNON, M.A.

Eight plates of Boss 4721 ($\alpha = 18^h\ 33^m \cdot 5$, $\delta = +33° \ 24'$) were taken in the years 1915 and 1916. The total range is about 11 km., probably due to error in wave-length or measurement. So far as these plates go the velocity of the star may be considered constant and approximately equal to the mean below.

LINES MEASURED

Wave-length	Element	Wave-length	Element
4549·766	*Fe*	4128·211	*Si*
4481·400	*Mg*	4101·890	*H*
4340·634	*H*	3933·825	*Ca*
4131·047	*Si*		

OBSERVATIONS

Plate	Date	Velocity
7042	1915, June 1·741	−23·6 km. per sec.
7051	June 6·706	−28·3 "
7099	July 13·660	−29·8 "
7154	Aug. 11·660	−30·4 "
7687	1916, June 5·734	−23·3 "
7734	July 14·660	−32·8 "
7792	Aug. 18·590	−34·1 "
7799	Aug. 25·573	−32·0 "
	Mean	= −29·3 km. per sec.

MEASURES OF BOSS 4721

λ	7042		7051		7099		7154		7687		7734		7792	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	−32·18	¼	−42·21	¼	......	......	......	......	......	......	......	......	......	......
4481·400	−40·40	¼	−28·69	¼	−23·08	¼	− 9·10	¼	−20·09	¼	−14·83	¼	−20·08	½
4340·634	−35·63	¼	−32·52	¼	−32·08	½	−17·11	¼	−35·77	½	−23·62	½	−31·28	½
4131·047	−20·10	¼	−30·81	¼	......	......	......	......	......	......	−33·42	¼	......	......
4101·890	......	......	......	......	−17·44	¼	−34·20	¼	......	......	......	......	−10·02	¼
3933·825	......	......	−44·23	¼	−31·56	¼	......	......	−31·22	¼	−56·60	¼	......	......
Weighted mean	− 32·08		− 35·69		− 27·25		− 20·48		− 30·71		− 30·41		− 22·55	
V_a	+ 8·73		+ 7·55		− 2·26		− 9·58		+ 7·60		− 2·74		− 11·21	
V_d	+ ·07		+ ·13		+ ·04		− ·10		+ ·07		+ ·02		− ·02	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 23·6		− 28·3		− 29·8		− 30·4		− 23·3		− 32·8		− 34·1	

MEASURES OF BOSS 4721—*Concluded*

λ	7799													
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481·400	−17·82	½												
4340·634	−19·94	½												
4101·890	−28·53	¼												
3933·825	−11·05	¼												
Weighted mean	− 19·18													
V_a	− 12·55													
V_d	− ·04													
Curv.	− ·28													
Radial Velocity	− 32·0													

Dominion Observatory
Ottawa
December, 1916.

MEASURES OF RADIAL VELOCITY OF 59 HERCULIS

BY J. B. CANNON, M.A.

Twenty-five plates of this star ($\alpha = 16^h\ 58^m{\cdot}4$, $\delta = 33°\ 42'$) were taken in the year 1915. A number of the plates seem to indicate that there may be a variation in the radial velocity, but the average deviation from the mean is less than 5 km., which is perhaps as small as one could expect if the velocity of the star were constant. The lines measured are:—

Wave-length	Element	Wave-length	Element
4549·766	*Fe*	4215·668	*Fe*
4481·400	*Mg*	4128·211	*Si*
4352·006	*Cr-Mg*	4101·890	*H*
4340·634	*H*	4045·975	*Fe*
4233·328	*Mn-Fe*	3933·825	*Ca*

OBSERVATIONS OF 59 HERCULIS

Plate	Date	Julian Day	Velocity
	1915		
6943	April 20·834	2,420,608·834	− 8·4 km. per sec.
6955	" 28·863	616·863	+ 1·2
6975	May 9·753	627·753	−18·8
7017	" 27·692	645·692	−11·4
7031	" 30·758	648·758	− 4·6
7060	June 16·667	665·667	−23·7
7069	" 20·706	669·706	− 7·5
7074	" 25·589	674·590	−23·5
7092	July 9·639	688·639	−19·4
7096	" 12·618	691·618	− 2·3
7101	" 14·635	693·635	−12·2
7105	" 15·665	694·665	−14·9
7108	" 19·681	698·681	− 9·2
7115	" 22·690	701·690	−11·8
7122	" 26·647	705·647	−15·0
7127	" 27·640	706·640	−17·0
7132	" 29·663	708·663	−13·1
7140	Aug. 5·633	715·633	−10·9
7143	" 9·621	719·621	−16·8
7147	" 10·621	720·621	−21·0
7162	" 23·545	733·545	−16·9
7169	" 26·594	736·594	− 6·3
7186	Sept. 1·576	742·576	−14·3
7234	" 11·524	752·524	−23·5
7267	" 19·562	760·562	−13·3
		Mean =	−13·4 km. per sec.

MEASURES OF 59 HERCULIS

λ	6943		6955		6975		7017		7031		7060		7069	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	−37·51	½	− 7·97	½	−25·61	½	− 9·54	½	− 4·72	¼	−17·38	½	+18·04	¼
4481·400	−22·20	½	− 1·83	½	−10·86	½	−27·68	½	− 6·73	½	−26·69	½	− 6·36	½
4352·006	−20·55	¼	....	....	....	....	−12·26	¼	−13·73	¼	−28·71	¼	....	....
4340·634	− 8·66	½	− 6·19	½	−34·50	½	+ 2·81	½	+ 7·09	½	−14·52	½	− 9·91	½
4233·328	− 3·84	¼	−15·44	¼	....	....	....	....	+ 0·51	¼	−10·57	¼	+ 4·66	¼
4215·668	− 4·91	¼	−12·06	¼	....	....	....	....	....	....	....	....	+ 9·59	¼
4128·211	....	....	....	....	−19·25	¼	− 8·18	¼	....	....	....	....	....	....
4101·890	−17·79	¼	+ 6·12	¼	−30·22	¼	− 2·97	¼	....	....	−18·84	½	− 7·92	¼
4045·975	−17·15	¼	−14·38	¼	−24·42	¼	−12·01	¼	−14·39	¼	....	....	....	....
3933·825	....	....	....	....	−24·70	¼	−18·82	½	− 3·34	¼	− 8·91	¼	− 2·22	¼
Weighted mean	− 18·27		− 6·77		− 23·97		− 11·65		− 3·88		− 18·46		− 1·15	
V_a	+ 10·11		+ 8·19		+ 5·38		+ 0·45		− 0·41		− 5·03		− 6·08	
V_d	± ·00		+ ·07		+ ·06		+ ·07		− ·04		+ ·03		− ·07	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 8·4		+ 1·2		− 18·8		− 11·4		− 4·6		− 23·7		− 7·5	

MEASURES OF 59 HERCULIS—*Continued*

λ	7074		7092		7096		7101		7105		7108		7115	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	−13·58	½	−12·38	½	+13·21	½	−15·82	½	−11·89	½	+ 0·26	½	+ 7·05	½
4481·400	−24·80	½	−21·94	½	− 0·12	½	+ 8·85	½	+ 6·24	½	+ 1·25	½	+ 3·12	½
4352·006	....	....	....	....	....	....	....	....	+ 0·34	¼	+16·15	¼	....	....
4340·634	−14·30	½	− 4·91	¼	+10·46	½	+ 7·10	½	−11·71	¼	....	....	....	....
4233·328	....	....	....	....	+19·68	¼	....	....	+ 0·51	½	+ 5·28	¼	− 5·38	¼
4215·668	− 6·84	¼	....	....	....	....	....	....	....	....	....	....	....	....
4101·890	....	....	....	....	....	....	− 7·22	¼	....	....	....	....	....	....
4045·975	....	....	....	....	....	....	....	....	....	....	....	....	− 1·24	½
3933·825	....	....	+ 6·92	½	+ 6·44	¼	+ 2·07	½	....	....	+ 6·04	½	....	....
Weighted mean	− 16·03		− 8·53		+ 9·15		− 0·31		− 2·70		+ 3·81		+ 1·78	
V_a	− 7·32		− 10·56		− 11·18		− 11·59		− 11·84		− 12·58		− 13·07	
V_d	+ ·14		− ·04		− ·01		− ·05		− ·11		− ·14		− ·16	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 23·5		− 19·4		− 2·3		− 12·2		− 14·9		− 9·2		− 11·8	

MEASURES OF 59 HERCULIS—*Continued*

λ	7122		7127		7132		7140		7143		7147		7162	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	− 2·35	½	− 9·54	½	− 5·10	¼	+ 2·22	½	+ 0·78	½	− 9·15	¼	+ 1·44	½
4481·400	+ 3·87	½	+ 0·25	½	+ 3·86	1	+ 4·95	1	− 1·37	1	−10·59	1	− 2·82	½
4352·006	− 9·54	¼	...	...	...	...	...	...	...	...	...	...	...	...
4340·634	+ 9·01	½	+ 0·34	½	+ 6·64	½	− 5·62	½	− 1·80	½	+ 1·24	½	+10·46	¼
4233·328	...	...	...	...	...	...	...	...	...	...	− 3·42	¼	...	...
4101·890	−18·56	½	−16·05	¼	−15·75	¼	+16·41	½	...	...	+ 7·42	¼	...	...
4045·975	...	...	...	...	...	...	...	...	...	...	...	...	− 8·47	¼
3933·825	+16·22	....	+12·25	¼	+ 3·34	½	...	...	...	...	...	...	...	...
Weighted mean	− 0·94		− 2·71		+ 1·45		+ 4·58		− 0·94		− 5·00		− 0·13	
V_a	− 13·71		− 13·86		− 14·14		− 15·05		− 15·47		− 15·57		− 16·39	
V_d	− ·12		− ·11		− ·16		− ·14		− ·14		− ·14		− ·09	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 15·0		− 17·0		− 13·1		− 10·9		− 16·8		− 21·0		− 16·9	

MEASURES OF 59 HERCULIS—*Concluded*

λ	7169		7186		7234		7267							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	+10·33	¼	+ 8·53	¼	+ 0·52	½	− 4·71	½						
4481·400	+11·60	½	− 0·99	1	−10·22	½	+ 6·36	1						
4340·634	+ 9·91	½			−14·06	¼	− 2·48	½						
4101·890					+ 7·52	¼								
3933·825			+11·05	¼	−14·86	½								
Weighted mean	+ 10·66		+ 2·60		− 6·95		+ 2·77							
V_a	− 16·47		− 16·51		− 16·18		− 15·58							
V_d	− ·16		− ·16		− ·13		− ·22							
Curv.	− ·28		− ·28		− ·28		− ·28							
Radial Velocity	− 6·3		− 14·3		− 23·5		− 13·3							

Dominion Observatory
Ottawa
December, 1916.

MEASURES OF RADIAL VELOCITY OF μ VIRGINIS

BY J. B. CANNON, M.A.

Sixty-one plates of this star ($\alpha = 14^h\ 37^m \cdot 8$, $\delta = -5° \ 13' \cdot 4$) were taken here, fifty in the years 1913 and 1914, and eleven in 1916. These latter were taken close together to test for a short period. Ten measures were published in *L.O.B. 199*, which are given in Table I. The total range in the ten plates was 19 km., a rather small range to work on with our dispersion, but it was thought that a greater range might appear. The type is F5, and magnitude 4·0. The earlier plates were measured by Mr. Parker, who was working on the star at that time. The measures are now published because it is hardly probable that an orbit could be obtained with the present equipment, and, indeed, doubtful from our results if the star is a binary. There is the possibility that it may be a binary with a long period. The measures of 1913 and 1916 seem to be generally more positive than those of 1914. The thirty-one plates of 1913 give a mean of +8·9; nineteen taken in 1914, a mean of +2·8; and eleven in 1916, a mean of +7·7. It would be necessary to continue for some years and take a considerable number of plates each year to make sure of this.

TABLE I

LICK OBSERVATORY OBSERVATIONS

Date	Velocity	Date	Velocity
1898, Apr. 15·861	+ 6	1907, Apr. 8·921	+11
1899, Feb. 15·013	± 0	1910, Feb. 11·097	+ 2
1899, May 2·802	+ 1	1911, Apr. 20·815	+ 1
1904, May 23·786	− 2	1911, Apr. 30·852	+ 6
1905, Apr. 10·840	+17		
1906, Apr. 2·974	+ 5		
	+ 8		

TABLE II

OBSERVATIONS OF μ VIRGINIS

Plate	Date	Julian Day	Velocity
	1913		
5354	Feb. 6·931	2,419,805·931	+14·1
5378	" 17·851	816·851	+11·9
5405	" 25·881	824·881	+14·5
5423	Mar. 7·861	834·861	+ 9·0
5443	Apr. 1·812	859·812	+ 4·2
5452	" 7·776	865·776	+11·7
5461	" 9·756	867·756	+10·4
5465	" 13·772	871·772	+ 2·4
5474	" 14·771	872·771	+13·2
5478	" 15·801	873·801	+ 9·5
5482	" 16·705	874·705	+ 8·6
5494	" 20·703	878·703	+ 7·6
5508	" 24·681	882·681	+10·8
5516	" 29·811	887·811	− 0·7
5526	May 1·670	889·670	+16·5
5541	" 7·691	895·691	+10·8
5546	" 11·769	899·769	+10·6
5552	" 14·687	902·687	− 1·4
5556	" 25·699	913·699	+12·2
5561	" 29·458	917·458	+ 9·4
5564	June 4·734	923·734	+ 8·3
5570	" 8·665	927·665	− 0·5
5574	" 9·637	928·637	+10·6
5581	" 13·639	932·639	+ 8·3
5587	" 16·644	935·644	+ 3·0
5593	" 18·649	937·649	+11·0
5600	" 25·651	944·651	+14·0
5607	July 7·630	956·630	− 0·4
5614	" 11·642	960·642	+ 2·4
5618	" 14·626	963·626	+17·0
5625	" 21·601	970·601	+15·5
	1914		
5960	Feb. 23·828	2,420,187·828	+ 5·5
5965	" 24·909	188·909	+ 6·5
6001	Mar. 30·767	222·767	+12·4
6004	" 31·771	223·771	+ 1·0
6011	Apr. 3·758	226·758	− 0·7
6018	" 6·749	229·749	+ 6·9
6023	" 9·711	232·711	−10·4
6034	" 16·717	239·717	+ 3·3
6056	May 1·734	254·734	+ 5·1
6062	" 6·685	259·685	+ 7·7
6065	" 7·673	260·673	− 2·7
6068	" 8·748	261·748	− 3·2
6073	" 14·682	267·682	+ 9·0
6075	" 15·752	268·752	+ 7·3

TABLE II

OBSERVATIONS OF μ VIRGINIS—*Concluded*

Plate	Date	Julian Day	Velocity
	1914		
6113	June 17·658	2,420,301·658	− 1·3
6119	" 19·612	303·612	+ 3·4
6133	" 26·646	310·646	+ 5·4
6143	July 3·594	317·594	− 2·8
6173	" 13·602	327·602	+ 0·9
	1916		
7552	Mar. 17·769	940·769	+10·5
7553	" 17·800	940·800	+13·9
7567	" 22·797	945·797	+ 7·8
7568	" 22·842	945·842	+10·6
7574	" 23·833	946·833	+ 7·6
7579	" 28·780	951·780	+ 8·0
7580	" 28·808	951·808	+ 3·0
7581	" 29·807	952·807	+ 1·8
7582	" 29·837	952·837	+ 5·3
7588	" 30·753	953·753	+ 7·0
7589	" 30·778	953·778	+ 9·3

MEASURES OF μ VIRGINIS

λ	5354 Vel.	5354 Wt.	5378 Vel.	5378 Wt.	5405 Vel.	5405 Wt.	5423 Vel.	5423 Wt.	5443 Vel.	5443 Wt.	5452 Vel.	5452 Wt.	5461 Vel.	5461 Wt.
4549·736	−11·47	½	−15·87	½	− 2·80	¼	......	......	......	......	−14·12	¼	......	......
4481·514	− 4·26	½	−11·31	¼	−15·22	¼	......	......	......	......	+14·88	¼	−18·29	¼
4340·677	−13·29	½	− 6·35	½	−21·28	1	−19·65	½	−12·14	½	+ 5·45	½	+ 0·93	½
4290·034	......	......	−28·60	¼	......	......	− 9·42	¼	......	......	+ 0·85	¼	− 5·07	¼
4233·415	−12·42	½	−17·31	½	+10·77	½	−12·20	¼	......	......	− 4·34	¼	+10·08	½
4215·689	......	......	−30·61	¼	− 9·44	¼	− 8·04	½	......	......	− 4·86	¼	− 5·01	¼
4101·852	−28·31	½	−24·73	¼	−20·10	½	−18·56	¼	− 6·24	½	+ 5·87	¼	+20·32	¼
4071·901	......	......	− 7·38	¼	......	......	......	......	......	......	......	......	+ 4·12	¼
4045·861	−14·37	½	−28·23	¼	− 8·04	¼	−17·10	¼	− 9·50	½	......	......	− 7·95	½
4026·352	−21·81	½	− 5·68	½	−10·56	¼	......	......	......	......	......	......	......	......
Weighted mean	− 15·13		− 15·80		− 11·53		− 14·08		− 9·29		+ 1·14		+ 0·56	
V_a	+ 29·39		+ 27·94		+ 26·23		+ 23·41		+ 13·65		+ 10·90		+ 9·97	
V_d	+ ·02		+ ·12		+ ·01		− ·04		− ·04		± ·00		+ ·04	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 14·1		+ 11·9		+ 14·5		+ 9·0		+ 4·2		+ 11·7		+ 10·4	

MEASURES OF μ VIRGINIS—*Continued*

λ	5465		5474		5478		5482		5494		5508		5516	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·736	+ 9·86	¼	+10·12	¼	+20·24	¼	− 1·73	½	+ 6·26	½	+ 6·51	¼	− 6·79	½
4481·514	....	....	−18·54	¼	+ 7·21	¼	− 5·92	¼	+ 1·18	¼	+ 9·96	¼	....	....
4340·677	− 8·94	1	+14·56	½	− 5·31	½	+ 5·09	½	+ 9·71	½	− 0·58	½	− 8·20	½
4290·034	−16·67	¼	− 2·82	¼	+ 8·20	¼	− 4·16	¼	+10·98	¼	+11·96	¼	+ 8·95	¼
4233·415	+ 8·08	¼	+19·41	¼	+ 0·84	¼	+12·49	½	+10·86	¼	− 0·92	½	+14·38	¼
4215·689	+ 4·79	¼	+20·40	¼	−10·04	¼	− 1·06	¼	− 6·84	¼	+16·39	¼	+ 4·19	½
4101·852	−13·94	½	+ 5·29	½	− 4·55	½	− 0·92	½	− 0·27	½	+22·28	½	+ 2·51	¼
4071·901	....	....	....	....	− 8·40	¼	+ 9·57	½	+ 4·54	¼	+ 5·86	¼	....	....
4045·861	+ 5·19	¼	− 5·18	¼	+19·32	½	− 2·08	¼	+ 0·14	¼	+ 6·84	¼	− 7·65	¼
4026·352	−10·53	¼	....	....	− 0·89	¼	− 4·75	¼	−10·37	¼	− 3·81	¼	....	....
Weighted mean	− 5·24		+ 6·31		+ 2·78		+ 2·07		+ 3·22		+ 8·10		− 0·34	
V_a	+ 8·04		+ 7·11		+ 7·05		+ 6·79		+ 4·65		+ 2·67		+ ·12	
V_d	− ·08		− ·03		− ·10		± ·00		− ·03		+ ·12		− ·18	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 2·4		+ 13·2		+ 9·5		+ 8·6		+ 7·6		+ 10·8		− 0·7	

MEASURES OF μ VIRGINIS—*Continued*

λ	5526		5541		5546		5552		5556		5561		5564	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·736	+15·03	½	+ 6·79	¼	+ 5·19	¼	+16·93	¼	+32·10	½	+27·81	¼	+38·02	¼
4481·514	....	....	+16·71	½	+11·26	¼	+10·91	¼	+22·10	½	+37·69	¼	....	....
4351·962	+24·76	¼	+19·88	¼	....	....	− 0·03	¼	....	....	....	....	....	....
4340·677	+25·99	½	+ 9·56	½	+14·20	½	+ 0·12	½	+22·66	¼	+ 8·87	½	+18·00	½
4290·034	+ 9·75	¼	+ 1·84	¼	+13·62	½	+15·45	¼	+24·37	¼	....	....	+22·88	¼
4271·674	+19·94	¼	+13·32	½	+25·29	¼	− 4·00	¼	+18·20	¼	+35·82	¼	+24·21	¼
4233·415	− 1·56	½	+15·94	½	+19·00	½	+ 8·42	¼	+26·48	¼	+24·65	¼	+29·52	¼
4215·689	+27·22	¼	....	....	....	....	+15·51	¼	....	....	+25·32	¼	+25·82	¼
4101·852	+30·42	½	+14·31	½	+26·29	½	− 2·97	¼	+23·80	½	+19·32	¼	....	....
4071·901	+12·36	¼	+25·30	¼	....	....	....	....	....	....	....	....	....	....
4045·861	+11·88	¼	+22·60	½	+ 9·04	½	....	....	....	....	....	....	....	....
Weighted mean	+ 17·55		+ 14·92		+ 16·67		+ 6·04		+ 24·77		+ 23·54		+ 25·20	
V_a	− 0·80		− 3·77		− 5·62		− 7·15		− 12·24		− 13·80		− 16·47	
V_d	+ ·09		± ·00		− ·14		− ·04		− ·10		− ·07		− ·18	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 16·5		+ 10·8		+ 10·6		− 1·4		+ 12·2		+ 9·4		+ 8·3	

MEASURES OF μ VIRGINIS—*Continued*

λ	5570		5574		5581		5587		5593		5600		5607	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·736	+27·40	¼	+40·87	¼	+ 2·53	¼	+25·98	¼	....	....	+48·05	¼	+40·02	¼
4481·514	− 4·14	½	+28·01	¼	....	....	+21·52	¼	....	....	+38·06	¼	+19·28	½
4340·677	+28·02	½	+24·79	½	+29·65	½	+27·22	½	+32·64	½	+32·50	½	+15·12	½
4290·034	+32·98	¼	+32·05	¼	+30·92	¼	+15·64	¼	+37·06	¼	+32·92	¼	+44·70	¼
4271·674	+22·67	¼	....	....	+29·36	½	+13·30	¼	+32·42	½	+33·97	¼	+32·52	¼
4233·415	+16·59	½	+29·72	½	+20·40	½	+29·90	½	+31·92	¼	+50·10	½	+26·76	¼
4215·689	....	....	+25·94	¼	+36·16	¼	+14·52	¼	....	....	....	....	....	....
4101·852	+ 5·19	¼	+20·36	¼	+43·01	¼	....	....	....	....	+25·15	¼	....	....
4071·901	....	....	....	....	+28·16	¼	....	....	....	....	....	....	....	....
4045·861	....	....	+33·10	½	+43·32	¼	+36·68	¼	+32·02	¼	....	....	....	....
Weighted mean	+ 16·92		+ 29·31		+ 28·75		+ 24·18		+ 33·01		+ 38·15		+ 26·60	
V_a	− 17·02		− 18·38		− 19·85		− 20·87		− 21·54		− 23·65		− 26·47	
V_d	− ·12		− ·08		− ·10		− ·12		− ·14		− ·14		− ·19	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 0·5		+ 10·6		+ 8·3		+ 3·0		+ 11·0		+ 14·0		− 0·4	

MEASURES OF μ VIRGINIS—*Continued*

λ	5614		5618		5625		5960		5965		6001		6004	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·736	+27·68	¼	+48·03	¼	+44·71	¼	−22·40	¼	....	....	− 3·12	½	....	....
4481·514	+25·50	¼	+40·28	¼	+37·42	¼	− 4·95	¼	....	....	....	....	+ 7·32	¼
4351·962	....	....	....	....	+33·39	¼	−20·61	¼	−10·12	¼	−19·59	¼	....	....
4340·677	+44·42	½	+45·43	½	+32·76	¼	−12·50	½	−17·14	1	+ 0·05	½	−12·96	½
4290·034	+31·78	¼	+53·95	¼	+62·72	¼	−36·72	¼	−12·22	¼	−12·35	¼	−33·88	¼
4271·674	....	....	+48·95	½	+38·48	½	−17·06	½	−17·16	¼	+12·75	¼	− 3·23	¼
4233·415	+18·69	¼	....	....	+44·12	¼	−32·32	¼	−29·71	½	....	....	−18·16	½
4215·689	+24·32	½	....	....	+42·06	¼	−19·90	¼	−14·97	¼	....	....	− 2·94	¼
4101·852	....	....	+39·72	¼	+56·92	½	−27·31	¼	−24·81	½	− 2·52	½	−11·76	¼
4071·901	....	....	....	....	....	....	−19·96	¼	....	....	....	....	....	....
4045·861	....	....	+35·08	¼	....	....	....	....	....	....	+ 4·68	¼	....	....
4026·352	....	....	....	....	....	....	−30·82	¼	−24·72	¼	+ 1·14	¼	−17·90	½
Weighted mean	+ 30·14		+ 45·09		+ 44·37		− 21·09		− 19·75		− 2·05		− 12·96	
V_a	− 27·21		− 27·51		− 28·45		+ 26·78		+ 26·53		+ 14·67		+ 14·22	
V_d	− ·22		− ·21		− ·20		+ ·12		− ·04		+ ·06		+ ·04	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 2·4		+ 17·0		+ 15·5		+ 5·5		+ 6·5		+ 12·4		+ 1·0	

MEASURES OF μ VIRGINIS—*Continued*

λ	6011		6018		6023		6034		6056		6062		6065	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·736	−11·91	¼	....	....	−33·11	¼	−20·70	¼	+ 6·75	¼	....	....	− 3·36	¼
4481·514	....	....	....	....	....	....	−15·21	¼	+ 4·89	¼	....	....	+ 2·28	¼
4351·963	....	....	....	....	−24·48	½	....	....	....	....	+15·03	¼	+ 1·95	½
4340·677	−13·18	½	+ 0·17	½	....	....	+ 8·31	½	+ 5·78	½	+15·90	½	− 0·68	¼
4290·034	−13·52	¼	....	....	....	....	−12·54	¼	....	....	+ 6·86	¼	....	....
4271·674	−18·05	¼	+ 1·92	¼	−21·46	¼	....	....	+ 0·45	¼	....	....	....	....
4233·415	....	....	....	....	−15·25	¼	+ 6·07	¼	+11·71	¼	+ 0·12	¼	−11·57	¼
4226·954	− 7·69	¼	−18·24	¼	+ 0·07	¼	....	....	+11·11	¼	− 1·26	¼	....	....
4215·689	....	....	....	....	....	....	....	....	....	....	....	....	− 0·44	¼
4101·852	−20·05	½	+ 0·34	½	−23·78	½	− 3·45	½	− 6·58	¼	+27·28	½	....	....
4071·901	− 6·63	¼	−12·50	¼	....	....	....	....	....	....	....	....	....	....
4026·352	−10·29	¼	− 5·32	½	−16·59	¼	+ 3·81	¼	+15·03	¼	+ 9·21	¼	+19·37	¼
Weighted mean	− 13·45		− 4·27		− 20·32		− 3·20		+ 6·10		+ 11·13		+ 1·20	
V_a	+ 12·88		+ 11·50		+ 10·11		+ 6·73		− 0·71		− 3·16		− 3·64	
V_d	+ ·04		+ ·06		+ ·12		+ ·06		− ·04		+ ·02		+ ·04	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 0·7		+ 6·9		− 10·4		+ 3·3		+ 5·1		+ 7·7		− 2·7	

MEASURES OF μ VIRGINIS—*Continued*

λ	6068		6073		6075		6113		6119		6133		6143	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·736	+ 8·14	¼	+17·54	¼	+18·47	¼	+ 0·52	¼	+37·18	¼	+ 6·32	¼	+21·07	½
4481·514	...		...		...		+36·92	¼	+32·08	½	...		...	
4351·962	− 2·45	¼	− 9·04	¼	...		+18·56	¼	+26·52	¼	+41·20	¼	...	
4340·677	...		+21·52	½	+13·33	½	+ 7·46	¼	+13·09	½	+39·80	½	+15·35	1
4290·034	−17·18	¼	+25·19	¼	+ 5·91	¼	+28·95	¼	+23·62	¼	+60·70	¼	+30·05	¼
4271·674	+ 1·90	¼	+27.50	¼	+11·34	¼	...		+33·55	¼	+18·76	¼	+21·70	¼
4233·415	+ 8·42	¼	...		...		+33·98	¼	+29·52	¼	+15·88	¼	+32·92	¼
4226·954	+ 3·18	¼	+ 5·03	¼	+29·52	¼	+19·14	¼	+ 4·62	¼	+37·58	¼	+12·76	¼
4215·689	...		...		...		+19·38	¼	+26·22	¼	+17·98	¼	+26·42	¼
4101·852	+ 7·80	¼	...		...		...		+32·38	¼	+27·36	¼	+33·20	½
4071·901	...		...		...		...		...		+21·08	¼	...	
4026·352	...		...		...		+16·74	¼	+25·97	¼	+30·21	¼	+30·91	¼
Weighted mean	+ 1·40		+ 15·61		+ 15·32		+ 20·19		+ 25·38		+ 29·72		+ 23·19	
V_a	− 4·18		− 6·38		− 7·55		− 21·14		− 21·77		− 23·86		− 25·60	
V_d	− ·12		− ·02		− ·16		− ·16		− ·07		− ·16		− ·12	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 3·2		+ 9·0		+ 7·3		− 1·3		+ 3·4		+ 5·4		− 2·8	

MEASURES OF μ VIRGINIS—*Continued*

λ	6173		7552		7553		7567		7568		7574		7579	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·736	+18·60	¼	−13·87	½	+15·25	¼	−16·62	½	−21·06	¼	....	....	+ 3·18	¼
4481·514	....	....	+ 1·69	¼	....	....	+ 5·19	¼	....	....	....	....	+12·70	¼
4351·962	+29·02	¼	....	....	− 6·12	¼	....	....	....	....	+ 8·14	¼	− 7·61	¼
4340·677	+41·80	¼	− 7·52	½	−11·71	½	− 1·87	½	−10·01	½	− 1·87	½	−13·28	½
4290·034	+28·00	¼	....	....	+ 0·52	¼	+ 2·35	¼	+10·51	¼	....	....	....	....
4271·674	+33·11	¼	−15·35	¼	−19·85	¼	−12·96	¼	+ 2·79	¼	−23·41	¼	−12·03	¼
4233·415	+33·13	¼	....	....	....	....	....	....	....	....	....	....	−13·06	¼
4226·954	+ 2·83	¼	−17·42	¼	− 4·13	¼	....	....	−12·10	¼	− 8·83	¼	+ 5·56	½
4215·689	+27·92	¼	− 4·68	¼	− 1·38	¼	....	....	....	....	+11·31	¼	−25·67	¼
4101·852	+44·75	½	−17·54	¼	+11·09	¼	− 9·88	½	− 7·93	½	−17·42	½	−13·80	¼
4063·612	....	....	− 0·31	¼	−20·12	¼	....	....	− 6·89	¼	−17·58	¼	....	....
4026·352	....	....	− 5·24	¼	−14·81	¼	−18·96	¼	− 0·10	¼	−26·12	¼	−13·20	¼
Weighted mean	+ 28·80		− 9·24		− 5·72		− 9·15		− 6·27		− 9·51		− 7·08	
V_a	− 27·48		+ 19·84		+ 19·84		+ 17·19		+ 17·19		+ 17·43		+ 15·32	
V_d	− ·17		+ ·12		+ ·08		+ ·02		− ·02		− ·03		+ ·05	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 0·9		+ 10·5		+ 13·9		+ 7·8		+ 10·6		+ 7·6		+ 8·0	

MEASURES OF μ VIRGINIS—*Concluded*

λ	7580		7581		7582		7588		7589					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·736	−10·88	¼	−11·20	¼	+ 0·43	¼	−21·00	¼						
4481·514							−11·56	¼						
4351·962	− 3·05	¼	−13·81	¼										
4340·677	−11·48	½	−10·88	½	− 9·42	½	− 3·67	½	− 1·71	½				
4290·034							−15·98	¼	−19·35	¼				
4271·674	−14·39	¼	− 8·31	¼										
4233·415					−27·41	¼								
4226·954	−19·08	¼			+ 4·46	¼	+ 4·93	¼	+ 9·99	¼				
4215·689	−18·72	¼					−11·64	¼	− 5·96	¼				
4101·852	−10·26	½	− 9·63	½			− 5·37	½	−19·74	½				
4063·612	− 7·08	¼					+ 1·92	¼	+14·54	¼				
4026·352	−15·32	¼	−28·20	¼	−13·58	¼	− 9·15	¼	+ 0·30	¼				
Weighted mean	− 12·00		− 12·82		− 9·16		− 7·32		− 4·82					
V_a	+ 15·32		+ 14·81		+ 14·87		+ 14·45		+ 14·45					
V_d	− ·06		− ·01		− ·09		+ ·09		+ ·04					
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28					
Radial Velocity	+ 3·0		+ 1·8		+ 5·3		+ 7·0		+ 9·3					

Dominion Observatory
Ottawa
December, 1916.

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 3

ORBIT OF THE SPECTROSCOPIC BINARY 2 SAGITTÆ

BY REYNOLD K. YOUNG, Ph.D.

The binary character of 2 Sagittæ ($\alpha = 19^h\ 20^m$, $\delta = +16°\ 46'$, type A3, mag. 6·2) was announced by Adams in the *Astrophysical Journal*, Vol. 35, page 177. Other designations for 2 Sagittæ are Boss 4947 and H.R.P. 7369. Forty-four spectrograms secured at this observatory, with a one-prism spectrograph, have been used in determining an orbit.

Shortly after the star was placed on the observing programme, it was discovered that both spectra were present. The widest separation between the components is somewhat over one hundred kilometres. These conditions make it difficult to determine accurate elements with the low dispersion used. However, the secondary spectrum is so much fainter than the primary, that the measures of blends, where such occur, tend to follow the primary curve. The elements may probably be regarded therefore as a first approximation. Better elements could be obtained with higher dispersion, for the lines when not confused by the secondary spectrum are fairly sharp and narrow.

Table I gives the data necessary for correcting the wave-lengths used in making the reductions. The residuals are taken in the sense, observed minus the mean of the plate. Several other lines besides those given in the table were occasionally measured.

The journal of observations taken at Mount Wilson and Ottawa follows in Tables II and III. Phases are counted from Julian Day 2,420,940·0. The residuals given in the eighth column are taken from the final curve, and should be accurate to the nearest kilometre. Those marked with an asterisk, result from plates which lie on that part of the orbit where the two sets of lines are not clearly separated and the velocity is the measure of the blend. Such measures were kept separate in forming the normal places, and in selecting preliminary elements allowance was made for the tendency of the measures of such blends to lie off the primary curve and toward the γ-axis.

TABLE I

Wave-Length	Element	Arithmetic Residual	Algebraic Residual	Number of times measured	Wave-Length	Element	Arithmetic Residual	Algebraic Residual	Number of times measured
4005·414	*Fe*	6·8	+ 0·6	6	4271·675	*Fe*	5·2	+ 0·9	11
4045·940	*Fe*	4·7	− 1·2	18	4307·974	*Fe*	3·4	+ 0·6	5
4063·730	*Fe*	5·7	+ 0·3	11	4351·977	*Cr–Mg*	6·2	− 0·6	7
4143·839	*Fe*	8·4	+ 0·9	8	4481·477	*Mg*	5·0	− 0·5	31
4215·733	*Fe*	5·1	− 0·6	9	4534·158	*Ti*	2·8	+ 2·4	8
4233·425	*Mg–Fe*	4·6	+ 2·8	11	4549·743	*Fe*	5·8	− 1·0	31

TABLE II

MOUNT WILSON OBSERVATIONS OF 2 SAGITTÆ

Date	Julian Day	Phase	Velocity	O–C
1911				
August 9	2,419,258·765	3·685	+ 61	− 5
October 31	341·657	5·287	+ 18	− 6

TABLE III

OTTAWA OBSERVATIONS OF 2 SAGITTÆ

Plate	Observer*	Date	Julian Day	Phase	Velocity	Weight	O–C	Velocity Secondary
		1916						
7575	Y	Mar. 23	2,420,946·892	6·892	−26·8	1	+ 7*	....
7577	Y	Mar. 25	948·888	1·498	− 0·3	1	+11*	....
7591	H	Mar. 30	953·892	6·502	−14·2	½	+ 9*	....
7597	H	April 2	956·894	2·104	+11·3	1	− 4	....
7605	Y	April 5	959·890	5·110	+31·0	1	0	....
7612	Y	April 14	968·847	6·677	−24·5	1	+ 4	....
7619	C	April 19	973·809	4·249	....	....	....	....
7631	H	May 2	986·838	2·498	+22·6	½	−11*	....
7636	Y	May 4	988·788	4·448	+54·8	1	− 1	....
7639	H	May 7	991·778	0·048	−35·5	½	+ 3	....
7647	H	May 9	993·787	2·057	+16·7	1	+ 2	....
7650	Y	May 13	997·802	6·072	+ 0·6	1	+10*	....
7666	Y	May 24	2,421,008·788	2·278	+11·1	1	−12*	....
7669	Y	May 25	009·786	3·276	+55·4	1	− 6	....
7672	H	May 26	010·777	4·267	+67·9	½	+ 7	−43·9
7675	H	May 28	012·762	6·252	....	....	....	....
7680	C	May 31	015·767	1·867	+ 4·8	1	0	....
7685	Y	June 1	016·820	2·920	+55·1	1	+ 5	−46·7
7692	H–Y	June 6	021·731	0·441	−31·5	1	+ 7	+86·6
7695	Y	June 13	028·670	7·380	−43·0	1	− 4	+93·9
7699	Y	June 17	032·816	4·136	+55·2	1	− 8	−63·8
7700	Y	June 20	035·705	7·025	−40·9	1	− 5	+78·1
7704	C	June 23	038·781	2·711	+35·6	½	− 8*	....
7706	Y	June 25	040·684	4·614	+45·3	1	− 6	−64·6
7710	Y	June 29	044·667	1·207	− 9·2	½	+13*	....
7714	C	June 30	045·647	2·187	....	....	....	....
7715	Y	July 4	049·816	6·356	− 4·0	½	+15*	....
7717	Y	July 5	050·691	7·231	−35·7	½	+ 2	+70·2
7724	Y	July 9	054·603	3·753	+71·4	1	+ 5	−63·6
7725	Y	July 9	054·687	3·837	+59·0	1	− 7	−72·3
7731	Y	July 13	058·747	0·507	−41·0	½	− 4	....
7738	Y	July 17	062·639	4·399	+68·4	1	+11	−64·7
7743	Y	July 19	064·601	6·351	−16·8	½	+ 2	....
7753	Y	July 23	068·625	2·995	+50·2	1	− 3	−66·9
7755	Y	July 24	069·595	3·965	+67·8	1	+ 3	−70·5
7767	Y	Aug. 1	077·603	4·588	+59·1	1	+ 8	−58·3
7771	Y	Aug. 2	078·590	5·575	+12·6	1	+ 1	....
7775	Y	Aug. 10	086·771	6·366	+ 8·0	0	....	....
7779	Y	Aug. 14	090·566	2·766	+38·6	1	− 9*	−45·7
7803	Y	Sept. 8	115·544	5·574	+ 9·0	1	− 2	....
7808	Y	Sept. 10	117·552	0·192	−33·4	1	+ 6	+94·8
7815	Y	Sept. 24	131·611	6·861	−37·6	½	− 5	....
7816	Y	Sept. 25	132·521	0·381	−48·6	1	− 9	+79·6
7829	Y	Oct. 1	138·589	6·449	−21·4	½	0	....
7842	Y	Oct. 3	140·513	0·983	−34·0	1	− 6	+85·8
7868	Y	Oct. 10	147·529	0·609	−42·2	1	− 6	....
7908	Y	Nov. 21	189·455	5·585	+ 7·4	1	− 4	....
7947	Y	Dec. 17	215·453	2·023	+21·5	1	+10	....

* H = Harper; C = Cannon; Y = Young.

MEASURES OF 2 SAGITTÆ

λ	7575*		7577*		7597		7605		7612		7636		7647	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005·414					− 14·6	½								
4045·940			− 3·3	½	− 11·4	½			− 44·6	½	+ 35·1	½	− 5·1	½
4063·730							+ 11·7	½					+ 0·9	½
4071·865			− 27·9	½					− 45·1	½			− 1·5	½
4128·214			− 20·6	½										
4143·839			− 7·8	½					− 63·5	½				
4215·733							+ 2·7	½						
4233·425	− 59·5	½	− 38·7	½			− 1·3	½	− 34·9	½			+ 0·8	½
4250·586													− 0·3	½
4271·675			− 21·8	½	− 1·4	½	+ 10·1	½					− 0·3	½
4290·053											+ 35·7	¼		
4307·974							+ 13·0	½			+ 29·9	½		
4340·645	− 38·6	½							− 50·8	½				
4351·977							− 1·8	½					− 3·5	½
4443·976	− 41·2	½									+ 22·2	½		
4481·477	− 48·4	1	− 25·9	1	− 16·5	1	+ 12·9	½	− 48·3	1	+ 41·0	1	− 7·1	1
4515·508					− 11·0	½							− 9·7	½
4534·158	− 56·2	½			− 3·6	½			− 45·7	½				
4549·743	− 45·7	½	− 26·0	½	− 15·5	½	+ 13·3	1	− 36·7	½	+ 30·4	1	− 9·6	1
4558·827			− 22·8	½										
4572·190									− 61·8	½				
4584·018									− 44·4	½				
Weighted mean	− 48·28		− 22·07		− 11·31		+ 8·21		− 47·65		+ 33·05		− 4·34	
V_a	+ 21·58		+ 21·87		+ 22·73		+ 22·94		+ 23·21		+ 21·87		+ 21·14	
V_d	+ 0·21		+ 0·21		+ 0·16		+ 0·15		+ 0·18		+ 0·20		+ 0·17	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 26·8		− 0·3		+ 11·3		+ 31·0		− 24·5		+ 54·8		+ 16·7	

MEASURES OF 2 SAGITTÆ—*Continued*

λ	7650* Vel.	Wt.	7666* Vel.	Wt.	7669 Vel.	Wt.	7680 Vel.	Wt.	7685 Vel.	Wt.	7692 Vel.	Wt.	7695 Vel.	Wt.
4005·414	....	....	− 5·9	½	+ 40·5	¼	....	....	+ 46·0	½	− 36·5	½	− 51·4	1
4045·940	− 15·3	½	....	....	+ 37·3	¼	....	....	+ 31·6	½	....	....	....	....
4063·730	− 28·4	½	....	....	+ 42·1	¼	....	....	+ 49·2	½	− 51·2	½	....	....
4071·865	....	....	....	....	....	....	− 16·0	½	....	....	....	....	....	....
4128·214	− 21·4	½	....	....	....	....	....	....	....	....	....	....	....	....
4143·839	....	....	....	....	....	....	....	....	....	....	− 44·8	½	− 58·4	1
4202·366	....	....	....	....	....	....	....	....	....	....	....	....	− 53·8	1
4215·733	− 21·4	½	....	....	....	....	....	....	....	....	....	....	− 51·4	1
4233·425	....	....	− 6·8	½	+ 39·2	½	− 10·0	½	....	....	....	....	....	....
4250·586	....	....	− 16·0	½	....	....	....	....	....	....	....	....	....	....
4271·675	....	....	....	....	+ 39·1	½	....	....	....	....	....	....	− 58·1	1
4300·211	− 19·1	½	....	....	....	....	....	....	....	....	....	....	....	....
4307·974	....	....	....	....	+ 42·2	½	− 9·4	½	+ 41·1	½	− 54·5	½	....	....
4351·977	− 7·4	½	− 10·3	½	+ 29·0	¼	....	....	....	....	....	....	− 59·7	1
4395·155	....	....	....	....	....	....	− 1·3	½	....	....	....	....	....	....
4443·976	− 11·9	½	....	....	....	....	....	....	....	....	....	....	....	....
4481·477	− 17·1	1	− 5·6	1	+ 30·5	1	− 19·4	1	+ 34·2	1	− 38·7	1	− 61·7	2
4534·158	− 19·7	½	....	....	....	....	....	....	+ 37·8	½	....	....	....	....
4549·743	− 30·4	1	− 2·0	1	+ 41·8	1	− 6·8	1	+ 41·3	½	− 56·1	½	− 47·5	2
4572·190	− 16·0	½	....	....	....	....	− 10·4	½	....	....	....	....	....	....
Weighted mean	− 19·66		− 6·77		+ 37·73		− 11·06		+ 39·43		− 45·79		− 55·12	
V_a	+ 20·41		+ 18·07		+ 17·82		+ 16·14		+ 15·95		+ 14·39		+ 12·21	
V_d	+ 0·12		+ 0·09		+ 0·09		± 0·00		± 0·00		+ 0·14		+ 0·15	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 0·6		+ 11·1		+ 55·4		+ 4·8		+ 55·1		− 31·5		− 43·0	

MEASURES OF 2 SAGITTÆ—*Continued*

λ	7699		7700		7704*		7706		7710*		7724		7725	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4045·940	+ 41·3	½	− 44·8	¼			+ 40·4	¼	− 20·1	½	+ 69·5	½	+ 55·8	½
4063·730			− 58·7	¼			+ 25·0	¼	− 30·6	½				
4143·839							+ 34·0	¼						
4215·733	+ 47·6	½												
4233·425			− 45·1	¼										
4236·000											+ 70·3	½		
4250·586					+ 20·2	¼			− 3·4	½				
4260·537			− 46·2	¼										
4271·675			− 56·0	¼							+ 65·5	½		
4290·053													+ 55·5	½
4307·974	+ 45·0	½	− 56·6	¼										
4315·178											+ 60·0	½	+ 50·6	½
4340·645					+ 25·9	¼	+ 28·2	¼						
4481·477	+ 54·2	1	− 49·3	1	+ 31·7	½	+ 44·2	½	− 13·8	1	+ 74·1	1	+ 61·0	1
4549·743	+ 26·2	½			+ 25·6	½	+ 41·8	½	− 12·3	½	+ 67·4	1	+ 54·3	½
Weighted mean	+ 44·75		− 50·46		+ 26·78		+ 37·45		− 15·67		+ 68·54		+ 56·36	
V_a	+ 10·84		+ 9·85		+ 9·12		+ 8·04		+ 6·63		+ 2·92		+ 2·88	
V_d	− 0·07		± 0·00		− 0·04		+ 0·12		+ 0·15		+ 0·18		+ 0·09	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 55·2		− 40·9		+ 35·6		+ 45·3		− 9·2		+ 71·4		+ 59·0	

MEASURES OF 2 SAGITTÆ—*Continued*

λ	7738		7743		7753		7755		7767		7771		7775	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005·414											+ 3·9	½		
4045·940			− 18·3	½	+ 66·0	½			+ 61·1	½	+ 1·1	½		
4063·730	+ 72·6	½			+ 54·6	½	+ 80·6	½	+ 56·4	½				
4071·865									+ 63·6	½				
4143·839					+ 59·5	½	+ 62·4	½			+ 30·2	½		
4202·366			− 19·5	½										
4215·733	+ 74·1	½					+ 72·1	½	+ 72·1	½				
4233·425									+ 71·9	½	+ 19·1	½		
4236·000			− 9·2	½										
4260·537											+ 22·0	½		
4271·675									+ 75·4	½	+ 10·8	½	+ 24·1	¼
4290·053											+ 22·4	½		
4307·974													+ 18·0	¼
4315·178									+ 74·8	½				
4351·977							+ 85·2	½					+ 22·1	¼
4481·477	+ 59·8	½	− 15·7	1	+ 46·7	1	+ 61·7	1	+ 54·3	1	+ 19·3	1	+ 23·0	1
4501·417											+ 21·3	½		
4515·508											+ 27·9	½		
4534·158									+ 66·9	½	+ 20·4	½		
4549·743	+ 68·6	½			+ 43·9	½	+ 71·3	1	+ 66·1	1	+ 17·7	½	+ 2·1	½
4572·190											+ 33·3	½		
Weighted mean	+ 68·77		− 15·68		+ 52·90		+ 70·79		+ 65·25		+ 19·12		+ 17·82	
V_a	− 0·12		− 0·94		− 2·50		− 2·88		− 5·94		− 6·31		− 9·31	
V_d	+ 0·02		+ 0·14		+ 0·10		+ 0·15		+ 0·10		+ 0·12		− 0·22	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 68·4		− 16·8		+ 50·2		+ 67·8		+ 59·1		+ 12·6		+ 8·0	

MEASURES OF 2 SAGITTÆ—*Continued*

λ	7779*		7803		7808		7868		7815		7816		7829	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4045·940					− 28·9	½	− 19·0	½			− 22·7	½		
4063·730	+ 56·0	½									− 10·0	½		
4071·865	+ 56·1	½												
4143·839					− 17·0	½	− 7·3	½						
4215·733											− 32·0	½		
4233·425			+ 29·0	½										
4236·000			+ 17·3	½										
4250·586	+ 40·7	½												
4260·537					− 20·8	½								
4271·675					− 18·6	½								
4290·053					− 20·9	½					− 22·5	½		
4307·974			+ 30·1	½										
4325·698							− 22·4	½						
4340·645							− 35·9	½						
4351·977	+ 43·7	½					− 19·3	½						
4395·155	+ 42·1	½												
4481·477	+ 55·4	1	+ 30·5	½	− 9·4	1	− 16·9	½	− 16·8	1	− 27·5	½	− 7·5	1
4534·158			+ 33·5	½										
4549·743	+ 47·8	1	+ 23·1	½	0·0	1	− 9·7	½	− 13·7	½	− 35·9	1	+ 10·5	1
4584·018					− 20·7	½								
Weighted mean	+ 49·44		+ 27·25		− 14·57		− 18·64		− 15·73		− 26·50		+ 1·50	
V_a	− 10·65		− 18·01		− 18·71		− 23·19		− 21·49		− 21·83		− 22·44	
V_d	+ 0·10		+ 0·02		− 0·03		− 0·12		− 0·18		− 0·02		− 0·18	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 38·6		+ 9·0		− 33·4		− 42·2		− 37·6		− 48·6		− 21·4	

MEASURES OF 2 SAGITTÆ—*Concluded*

λ	7842		7908		7947									
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4143·839	− 19·4	½												
4215·733	− 13·6	½	+ 14·5	½										
4233·425	− 8·9	½	+ 31·3	⅓										
4260·537	− 3·8	½												
4307·974			+ 31·3	½										
4340·645	− 17·4	½												
4395·155			+ 31·7	⅓										
4481·477	− 13·2	½	+ 30·5	⅓	+ 36·9	½								
4534·158			+ 28·9	½										
4549·743	− 4·5	½	+ 21·8	⅓	+ 30·2	½								
4584·018	− 8·7	½												
Weighted mean	− 11·18		+ 27·14		+ 33·55									
V_a	− 22·65		− 19·31		− 11·46									
V_d	− 0·07		− 0·18		− 0·28									
Curv.	− 0·28		− 0·28		− 0·28									
Radial Velocity	− 34·0		+ 7·4		+ 21·5									

The writer has found the following method of getting preliminary elements very satisfactory. With the aid of a complete set of "protractors", which the observatory possesses for the simplification of King's graphical method, curves were drawn on tracing linen, representing all orbits from eccentricity 0·0 to 0·7 and $\omega=0°$ to $\omega=360°$. The interval for the eccentricity is 0·05, save for the large values which are seldom used. The interval for ω is fifteen degrees. It might seem labourious to draw all these curves, but one curve will do for four values of ω by inverting the sheet or looking through the linen from the back, so that the labour is not so great as it appears at first sight. The construction of a complete set of curves occupies about ten hours, if the protractors are already at hand. The calculations need be made but once. In selecting a set of elements, the normal places are plotted on the scale of these curves. This supposes that we know the amplitude of the curve. Although this is unknown, it is the most easily determined of all the elements and can usually be selected with sufficient accuracy at the first trial. The curves are now fitted in turn over the normal places till the one most satisfactory is found. If two or more curves seem to give equally good representations, it is quite possible to interpolate elements between the graphs plotted, and so obtain a result with the eccentricity within one or two hundredths and ω within a few degrees.

In the present case a wide range of values of ω will satisfy the normal places about equally well. These values center about $\omega=330°$ and $e=0·05$. The uncertainty in the value of ω is partly dependent on the fact that the observations where the spectra are just separating can not be given much weight. In the least-square solution, recorded below, they were omitted, and to make the solution determinate periastron passage was fixed.

NORMAL PLACES

	Julian Day	Phase from J. D. 2,420,940·0	Velocity	Weight	O–C Preliminary	O–C Final
1	2,420,940·041	0·041	−37·3	1·0	+ 2·22	+ 2·09
2	940·481	0·481	−41·1	1·0	− 2·27	− 3·25
3	941·058	1·058	−25·7	0·5	+ 2·69	+ 0·77
4	941·971	1·971	+10·8	1·5	+ 3·95	+ 1·15
5	942·685	2·685	+33·8	. . .	− 6·16	− 8·57
6	943·064	3·064	+53·6	1·0	− 0·52	− 2·32
7	943·852	3·852	+66·0	1·0	+ 0·11	− 0·04
8	944·267	4·267	+63·0	0·8	+ 1·93	+ 2·70
9	944·550	4·550	+53·1	1·0	− 0·82	+ 0·46
10	945·110	5·110	+31·0	0·3	− 2·58	− 0·67
11	945·578	5·578	+ 9·7	1·0	− 3·94	− 1·80
12	946·300	6·300	− 9·2	. . .	+ 5·89	+ 7·68
13	946·864	6·864	−31·7	1·0	− 0·18	+ 0·70

PRELIMINARY ELEMENTS

$P = 7\cdot390$ days
$T =$ Julian Day $2{,}420{,}943\cdot233$
$K = 53\cdot0$ km.
$\omega = 330°$
$e = 0\cdot05$
$\gamma = +10\cdot70$ km.
$\mu = 48°\cdot7145$

OBSERVATION EQUATIONS

	x	y	z	p	q	−n	Weight
1...............	1	− 0·948	+ 0·966	− 0·110	+ 0·123	− 2·22	1·0
2...............	1	− 0·935	+ 0·593	+ 0·233	− 0·193	+ 2·27	1·0
3...............	1	− 0·738	− 0·289	+ 0·649	− 0·602	− 2·69	0·5
4...............	1	− 0·073	− 0·980	+ 1·018	− 1·033	− 3·95	1·5
6...............	1	+ 0·819	+ 0·661	+ 0·656	− 0·694	+ 0·52	1·0
7...............	1	+ 1·041	+ 0·803	− 0·031	+ 0·061	− 0·11	1·0
8...............	1	+ 0·950	+ 0·162	− 0·397	+ 0·447	− 1·93	0·8
9...............	1	+ 0·815	− 0·339	− 0·611	+ 0·659	+ 0·82	1·0
10...............	1	+ 0·431	− 0·962	− 0·897	+ 0·911	+ 2·58	0·3
11...............	1	+ 0·055	− 0·861	− 0·975	+ 0·953	+ 3·94	1·0
13...............	1	− 0·797	+ 0·813	− 0·517	+ 0·489	+ 0·18	1·0

Where $x = d\gamma$
$y = dK$
$z = Kde$
$p = Kd\omega$
$$q = \frac{K\mu}{(1-e^2)^{\frac{3}{2}}}\, dT$$

NORMAL EQUATIONS

$$10\cdot100x + 0\cdot461y + 0\cdot863z - 0\cdot089p - 2\cdot640 = 0$$
$$+ 5\cdot888y - 0\cdot851z - 0\cdot517p + 1\cdot326 = 0$$
$$+ 5\cdot666z - 0\cdot321p + 1\cdot129 = 0$$
$$+ 4\cdot218p - 10\cdot306 = 0$$

$$\begin{aligned} \text{whence, } dx &= +0{\cdot}295 \quad \text{or} \quad & d\gamma &= +0{\cdot}29 \text{ km.} \\ dy &= -0{\cdot}051 & dK &= -0{\cdot}05 \text{ km.} \\ dz &= -0{\cdot}114 & de &= 0{\cdot}00 \\ dp &= +2{\cdot}435 & \delta\omega &= +2^\circ{\cdot}63 \end{aligned}$$

FINAL ELEMENTS

$P = 7{\cdot}390$ days

$T =$ Julian Day 2,420,943·233

$\omega = 332^\circ{\cdot}6$

$e = 0{\cdot}05$

$K = 52{\cdot}95$ km.

$\gamma = +11{\cdot}0$ km.

$a \sin i = 5{,}370{,}000$ km.

$$\frac{m_1^3 \sin^3 i}{(m+m_1)^2} = 0{\cdot}11 \odot$$

Russell's short graphical method was tried after the foregoing solution was completed. This method agrees with the first in establishing the presence of eccentricity. The "anomaly" diagram, however, does not yield a smooth curve, and the position of periastron and ω remain somewhat uncertain.

The measures of the secondary spectrum are not of sufficient value to help in determining the elements of the primary. They were formed into two normal places as follows:—

Phase	Velocity	Weight	O–C
0·21	+84·1 km.	7	+ 2·7
3·84	−64·0 km.	11	+ 5·7

From these we obtain the following additional elements:—

$K_1 = 73{\cdot}8$ km.

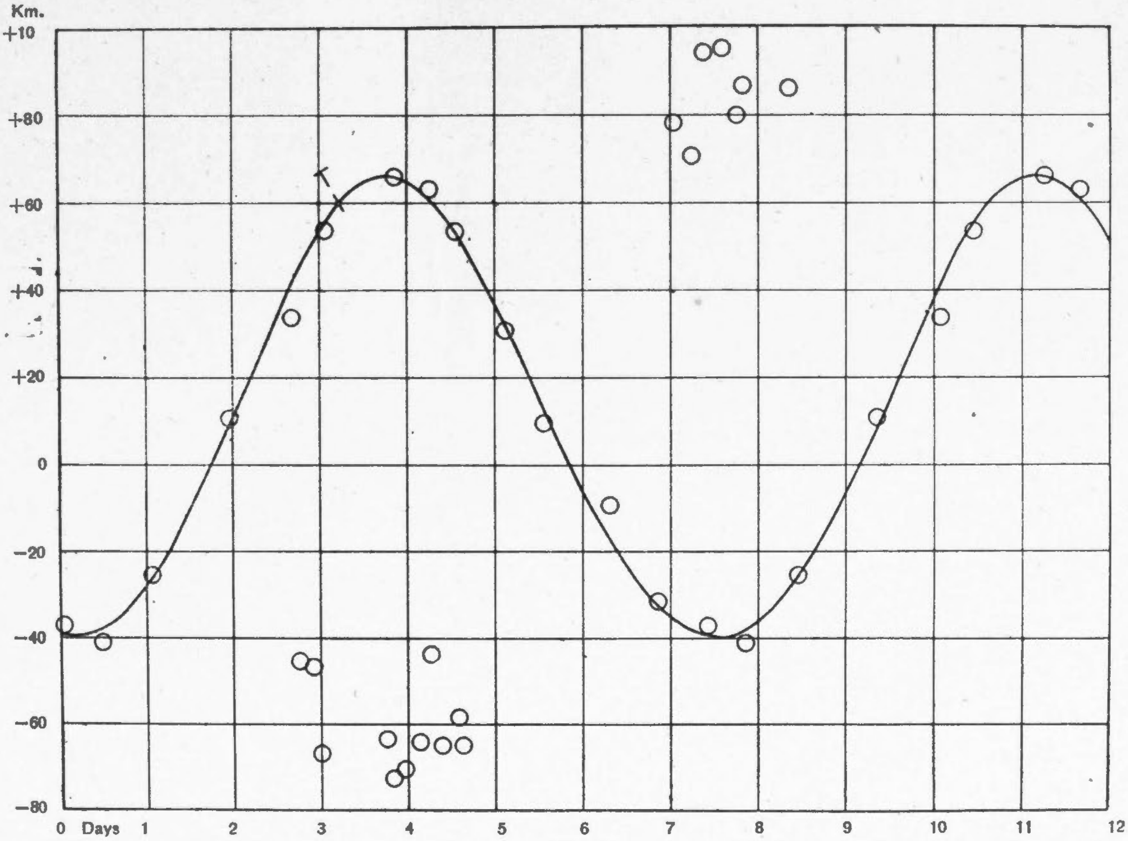
$a_1 \sin i = 7{,}490{,}000$ km.

$m_1 \sin^3 i = 0{\cdot}65 \odot$

$m \sin^3 i = 0{\cdot}91 \odot$

Dominion Observatory

Ottawa, January, 1917.



Radial Velocity Curve of 2 Sagittæ

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 4

ORBIT OF THE SPECTROSCOPIC BINARY [illegible]

[illegible]

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 4

ORBIT OF THE SPECTROSCOPIC BINARY π ARIETIS

BY REYNOLD K. YOUNG, Ph.D.

The binary character of π Arietis ($\alpha = 2^h\ 43^m{\cdot}7$, $\delta = +17°\ 3'$, mag. 5·30, type B5) was announced by Adams in the *Astrophysical Journal*, Vol. 35, p. 173. The present orbit is based on fifty spectrograms secured during the years 1914, 1915, 1916 and 1917.

The character of the spectrum prevents accurate determination of the orbital elements from any reasonable number of observations. The range is not very large, the lines are of poor quality, and measures of them subject to considerable uncertainty. So that the number of plates is inadequate to provide accurate values for the eccentricity and the longitude of periastron. The wave-lengths of the lines used are given in Table I. On account of their poor character, they were not adjusted to make the sum of the residuals zero. The material to do this, however, can be found in the table of measures.

TABLE I

λ	λ	λ
3933·825	4131·047	4388·100
4026·352	4143·928	4471·676
4101·890	4267·301	4481·400
4121·016	4340·634	

TABLE II

OBSERVATIONS OF π ARIETIS

Plate	Observer*	Date	Julian Day	Velocity	Weight	Phase from J. D. 2,420,370	O–C
Mt. Wilson	....	1910, Dec. 24............	2,419,030·693	− 9	....	1·885	−2
"	....	1911, Jan. 19............	056·700	−12	....	0·914	0
"	....	Feb. 10............	078·660	+32	....	3·400	−1
"	....	Dec. 12............	383·625	+ 7	....	0·249	−6
6310	H	1914, Aug. 25............	2,420,370·810	− 5·9	1·0	0·810	+3
6380	H	Sept. 15............	391·795	+14·5	1·5	2·525	0
6418	C	" 21............	397·785	−15·4	1·5	0·807	−6
6435	Y	" 27............	403·885	+36·4	1·5	3·053	+6
6450	C	" 30............	406·854	+ 1·8	1·5	2·168	−1
6482	H	Oct. 4............	410·768	+ 7·2	1·0	2·228	+2
6571	C–P[1]	Nov. 23............	460·689	− 5·9	1·0	2·047	−4
7406	Y	1915, Nov. 13............	815·762	+ 5·2	0·5	2·552	−11
7417	H	" 17............	819·784	+24·1	1·0	2·720	+2
7428	Y	" 24............	826·641	− 2·8	0·5	1·869	+5
7431	H	" 25............	827·578	+26·6	1·0	2·806	+2
7452	P	Dec. 20............	852·524	− 5·3	1·5	0·674	−1
7457	Y	" 28............	860·591	− 9·5	0·5	1·133	+6
7480	H	1916, Jan. 13............	876·507	−17·1	1·0	1·633	−4
7806	Y	Sept. 9............	2,421,116·868	+29·8	1·0	3·046	0
7825	Y	" 30............	137·862	−21·0	1·0	0·916	−9
7839	Y	Oct. 2............	139·855	+30·9	1·0	2·909	+3
7846	H	" 3............	140·872	+ 9·0	1·0	0·072	−12
7850	Y	" 4............	141·703	−10·4	1·0	0·903	+1
7860	H	" 6............	143·744	+27·6	1·0	2·944	−1
7866	Y	" 9............	146·661	+ 5·2	1·0	2·007	+8
7867	Y	" 9............	146·721	+ 4·1	0·5	2·067	+5
7871	Y	" 11............	148·627	+13·6	1·0	0·119	−5
7872	Y	" 11............	148·680	+23·3	1·0	0·172	+6
7880	Y	" 24............	161·726	−11·0	0·5	1·656	+2
7883	Y	" 29............	166·687	+13·0	0·5	2·763	+11
7885	Y	" 30............	167·681	+34·8	0·5	3·757	+9
7891	Y	Nov. 5............	173·589	− 7·6	1·0	1·957	−3
7892	Y	" 5............	173·640	− 9·1	1·0	2·008	−6
7895	Y	" 6............	174·741	+23·9	0·5	3·109	−7
7900	Y	" 14............	182·703	+25·9	1·0	3·363	−7
7904	H	" 20............	188·567	− 8·1	0·5	1·519	+7
7906	Y	" 20............	188·704	−18·0	1·5	1·656	−5
7910	Y	" 21............	189·582	+20·9	1·0	2·534	+5
7911	Y	" 21............	189·639	+21·3	1·5	2·591	+3
7948	Y	Dec. 17............	215·516	− 9·1	1·0	1·490	+6
7949	Y	" 17............	215·573	−15·5	1·0	1·547	−1
7953	Y	" 19............	217·535	+40·2	1·0	3·509	+8
7974	Y	" 30............	228·454	+22·5	1·0	2·866	−4
7975	Y	" 30............	228·504	+17·7	1·0	2·916	−10
7987	Y	1917, Jan. 12............	241·518	+ 0·3	1·0	0·514	−1
7988	Y	" 12............	241·575	+12·6	1·0	0·571	+13
7994	Y	" 16............	245·532	−10·7	1·0	0·674	−6
7996	Y	" 16............	245·608	+ 4·2	1·0	0·750	+11
8041	Y	Feb. 11............	271·479	+26·8	1·0	3·497	−5
8042	Y	" 11............	271·535	+32·7	1·5	3·553	+2
8051	Y	" 12............	272·483	− 5·0	1·5	0·645	−1
8057	Y	" 15............	275·533	+31·1	1·0	3·697	+3
8062	Y	" 18............	278·490	+25·7	1·5	2·800	+1
8097	Y	Mar. 6............	294·503	+36·4	1·5	3·397	+4

*P=Plaskett; H=Harper; C=Cannon; P[1]=Parker; Y=Young

MEASURES OF π ARIETIS

λ	6310		6380		6418		6435		6450		6482		6571	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	...	...	...	...	− 32·6	¼	+ 12·7	¼	− 13·6	¼	− 12·8	¼	+ 0·8	¼
4026·352	− 10·4	½	− 3·4	½	− 26·8	¼	+ 28·6	¼	− 26·0	¼	− 7·8	¼	+ 4·7	¼
4101·890	− 26·9	¼	− 13·0	½	− 40·8	¼	+ 23·2	¼	− 26·0	¼	...	...	...	...
4143·928	...	...	...	...	...	...	+ 19·2	¼	...	...	− 5·3	½	...	...
4121·016	...	...	...	...	...	...	...	...	...	...	− 10·4	¼	...	...
4340·634	− 19·1	¼	− 7·8	½	− 39·4	¼	+ 7·8	¼	+ 2·8	½	− 9·0	½	+ 10·6	¼
4388·100	− 37·3	¼	...	...	...	...	...	...	...	...	...	...	...	...
4471·676	− 48·9	½	− 9·2	½	− 37·7	¼	+ 13·6	¼	− 23·5	½	+ 14·2	¼	− 3·7	¼
4481·400	− 52·3	½	− 7·4	½	− 38·7	¼	...	...	− 15·0	½	− 19·9	¼	+ 6·2	¼
Weighted mean	−33·60		− 8·16		−36·00		+17·52		−15·11		− 8·21		+ 3·70	
V_a	+27·82		+22·80		+20·79		+18·49		+17·30		+15·66		− 9·22	
V_d	+ 0·14		+ 0·09		+ 0·09		− 0·14		− 0·10		+ 0·04		− 0·08	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 5·9		+ 14·5		−15·4		+36·4		+ 1·8		+ 7·2		− 5·9	

MEASURES OF π ARIETIS—*Continued*

λ	7406		7417		7428		7431		7452		7457		7480	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	....	....	....	....	....	....	....	....	+ 12·0	⅓	....	....	+ 31·6	¼
4026·352	....	....	+ 28·3	¼	....	....	+ 44·5	½	+ 29·6	⅓	+ 39·6	½	+ 36·6	¼
4101·890	....	....	+ 31·7	¼	+ 13·5	⅓	....	....	+ 26·1	¼	+ 12·1	⅓	00·0	¼
4143·928	....	....	+ 38·7	¼	....	....	....	....	....	....	....	....	+ 27·1	¼
4267·301	....	....	+ 38·5	¼	....	....	....	....	....	....	....	....	....	....
4340·634	+ 7·3	¼	+ 44·6	⅓	− 6·2	⅓	+ 27·1	½	+ 34·5	⅓	+ 3·9	½	+ 4·5	⅓
4388·100	+ 1·2	¼	+ 25·7	¼	....	....	+ 38·0	½	+ 13·5	1	....	....	....	....
4471·676	+ 31·0	¼	− 2·5	½	+ 17·8	⅓	+ 37·9	1	+ 1·9	1	+ 3·8	½	− 11·2	¼
4481·400	− 1·2	¼	+ 26·3	¼	+ 3·1	⅓	+ 54·4	½	....	....	....	....	+ 4·4	⅓
4131·047	....	....	....	....	....	....	+ 18·2	¼	....	....	....	....	....	....
Weighted mean	+9·57		+30·66		+7·05		+36·82		+16·00		+14·85		+11·31	
V_a	−4·00		− 6·08		−9·57		−10·02		−21·17		−24·01		−28·14	
V_d	−0·15		− 0·21		+0·01		+ 0·11		+ 0·12		− 0·07		+ 0·01	
Curv.	−0·28		− 0·28		−0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+5·2		+24·1		−2·8		+26·6		− 5·3		− 9·5		−17·1	

MEASURES OF π ARIETIS—*Continued*

λ	7806		7825		7839		7846		7850		7860		7866	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	....	....	− 46·1	½	....	....	....	....	....	....	....	....	....	....
4026·352	+ 13·0	½	− 19·1	½	+ 28·6	½	....	....	− 23·4	½	+ 4·3	½	....	....
4101·890	....	....	− 36·2	½	+ 19·6	½	....	....	− 14·8	½	+ 10·2	½	+ 19·5	½
4121·016	....	....	....	....	....	....	....	....	− 38·7	½	....	....	....	....
4143·928	− 6·2	½	....	....	....	....	....	....	....	....	....	....	....	....
4267·301	....	....	− 28·7	½	....	....	....	....	....	....	....	....	+ 3·2	¼
4340·634	− 11·3	½	− 46·2	½	+ 19·2	½	− 19·1	½	− 14·6	½	....	....	+ 19·2	¼
4388·100	− 4·7	½	− 42·0	½	+ 12·8	½	+ 11·6	½	− 51·3	½	....	....	− 2·3	¼
4471·676	+ 29·7	½	− 44·3	1	+ 1·2	½	− 7·4	½	− 3·7	½	+ 9·8	½	+ 7·4	¼
4481·400	+ 13·7	½	− 32·4	½	+ 8·7	½	− 10·6	½	− 33·1	½	+ 28·7	½	− 11·2	¼
Weighted mean	+ 5·70		−37·70		+15·01		− 6·38		−25·67		+13·25		− 8·00	
V_a	+24·42		+17·09		+16·28		+15·82		+15·45		+14·58		+13·27	
V_d	− 0·01		− 0·11		− 0·12		− 0·13		− 0·14		+ 0·09		+ 0·20	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+29·8		−21·0		+30·9		+ 9·0		−10·4		+27·6		+ 5·2	

MEASURES OF π ARIETIS—*Continued*

λ	7867		7871		7872		7880		7883		7885		7891	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825													+ 7·2	¼
4026·352	+ 5·2	½			+ 6·1	½							− 3·0	¼
4143·928											+ 32·2	½	− 5·3	¼
4340·634			− 6·7	½	+ 12·4	1	− 28·2	½	+ 18·0	½	+ 33·8	½	− 24·3	½
4388·100			+ 4·6	½	+ 12·2	½			− 16·3	½			− 9·3	½
4471·676	− 14·9	½	− 9·8	½			+ 1·2	½	+ 4·9	½	+ 3·7	½	− 12·4	½
4481·400	− 3·0	½	+ 17·6	½	+ 12·6	½	− 23·2	½	+ 32·4	½	+ 48·6	½	+ 11·3	½
4267·301													+ 10·1	¼
Weighted mean	− 8·95		+ 1·42		+11·14		−16·73		+ 9·75		+32·07		−7·37	
V_a	+13·24		+12·33		+12·33		+ 5·98		+ 3·45		+ 2·97		−0·13	
V_d	− 0·10		− 0·14		− 0·14		+ 0·01		+ 0·06		+ 0·06		+0·20	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		−0·28	
Radial Velocity	+ 4·1		+13·6		+23·3		−11·0		+13·0		+34·8		−7·6	

MEASURES OF π ARIETIS—*Continued*

λ	7892		7895		7900		7904		7906		7910		7911	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	.....	.....	.....	.....	.....	.....	.....	.....	+ 3·2	½	+ 35·2	½	+ 30·2	½
4026·352	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+ 24·0	¼
4101·890	− 1·4	½	.....	.....	+ 32·2	½	.....	.....	− 13·5	½	+ 25·7	½	.....	.....
4143·928	− 15·4	¼	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+ 38·2	½
4340·634	− 15·8	½	+ 21·4	½	.....	.....	.....	.....	− 10·2	1	+ 50·9	½	+ 31·1	½
4388·100	.....	.....	+ 40·8	½	+ 40·8	½	.....	.....	.....	.....	.....	.....	.....	.....
4471·676	0·0	½	+ 29·1	½	+ 34·6	½	+ 1·2	½	− 11·2	½	+ 28·8	½	+ 12·4	¼
4481·400	− 11·2	½	+ 8·7	½	+ 16·3	½	− 1·2	½	− 16·3	½	+ 6·2	½	+ 31·3	½
4121·016	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+ 31·7	¼
Weighted mean	−8·76		+25·00		+31·02		±0·00		−9·70		+29·32		+29·97	
V_a	−0·10		− 0·71		− 4·86		−7·96		−7·97		− 8·44		− 8·45	
V_d	+0·09		− 0·09		± 0·00		+0·14		−0·09		+ 0·08		+ 0·04	
Curv.	−0·28		− 0·28		− 0·28		−0·28		−0·28		− 0·28		− 0·28	
Radial Velocity	−9·1		+23·9		+25·9		−8·1		−18·0		+20·9		+21·3	

MEASURES OF π ARIETIS—*Continued*

λ	7948		7949		7953		7974		7975		7987		7988	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4026·352	....	....	....	....	....	....	+ 56·7	½	+ 48·8	½	....	....	....	....
4101·890	....	....	....	....	....	....	+ 33·6	½	....	....	....	....	+ 42·0	½
4340·634	+ 9·0	½	+ 12·0	½	+ 59·5	½	+ 29·4	½	+ 49·4	½	+ 17·5	1	+ 27·7	½
4388·100	+ 23·4	½	....	....	....	....	....	....	....	....	....	....	....	....
4471·676	+ 16·2	½	− 0·6	½	+ 63·5	½	+ 65·8	½	+ 38·6	½	+ 39·2	½	+ 42·5	½
4481·400	− 3·2	½	+ 4·4	....	+ 63·8	½	+ 51·9	½	+ 35·1	½	+ 40·0	½	+ 51·4	½
Weighted mean	+11·35		+ 5·26		+62·26		+47·48		+42·73		+28·55		+40·90	
V_a	−20·32		−20·32		−21·84		−24·80		−24·80		−27·95		−27·95	
V_d	+ 0·12		+ 0·09		+ 0·09		+ 0·15		+ 0·09		± 0·00		+ 0·05	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 9·1		−15·3		+40·2		+22·5		+17·7		+ 0·3		+12·7	

MEASURES OF π ARIETIS—*Continued*

λ	7994		7996		8041		8042		8051		8057		8062	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825							+ 58·3	½	+ 33·3	½				
4026·352	+ 33·2	½			+ 48·4	½	+ 52·7	½					+ 64·0	½
4101·890					+ 48·5	½			+ 20·0	½			+ 69·0	½
4143·928									+ 19·8	½			+ 32·4	½
4267·301									+ 22·4	½				
4340·634	+ 9·0	1	+ 30·0	½	+ 61·1	1	+ 56·6	½	+ 30·5	1	+ 51·5	½	+ 61·0	½
4388·100			+ 57·4	½	+ 62·0	½								
4471·676	+ 9·3	½	+ 18·6	½	+ 51·0	1	+ 73·7	½			+ 64·0	½	+ 42·9	½
4481·400	+ 20·7	¼	+ 26·3	½	+ 71·4	½	+ 73·9	½	+ 19·4	½	+ 67·6	½	+ 48·8	½
Weighted mean	+18·05		+33·07		+56·94		+62·98		+25·13		+61·03		+55·90	
V_a	−28·38		−28·40		−29·82		−29·82		−29·74		−29·42		−29·82	
V_d	− 0·07		− 0·18		− 0·09		− 0·18		− 0·10		− 0·20		− 0·14	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	−10·7		+ 4·2		+26·8		+32·7		− 5·0		+31·1		+25·7	

MEASURES OF π ARIETIS—*Concluded*

λ	8097													
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
3933·825	+ 52·0	½	......											
4026·352	+ 63·2	½	......											
4340·634	+ 61·0	1	......											
4388·100	+ 76·7	½	......											
4471·676	+ 62·8	½	......											
4481·400	+ 62·0	1	......											
Weighted mean	+62·59													
V_a	−25·65													
V_d	− 0·22													
Curv.	− 0·28													
Radial Velocity	+ 36·4													

Table II gives the journal of observations. These were formed into thirteen normal places.

NORMAL PLACES

	Julian Day	Phase from J. D. 2,420,370	Velocity	Weight	$(O–C)_1$	$(O–C)_2$	O–C Final
1	2,420,370	0·121	+15·30	0·6	−5·40	−3·89	−3·47
2	370	0·613	− 0·50	1·0	+1·95	+1·34	+1·59
3	370	0·765	− 7·90	0·9	+1·02	−0·38	−0·27
4	370	0·954	−14·50	0·5	+0·25	−1·64	−1·59
5	371	1·519	−11·50	0·5	+3·80	+3·40	+3·74
6	371	1·648	−16·50	0·6	−3·90	−3·86	−3·42
7	371	1·990	− 4·20	0·9	−1·42	−0·97	−0·36
8	372	2·171	+ 4·00	0·6	+0·75	+1·04	+1·55
9	372	2·552	+17·20	0·9	+1·34	+0·61	+0·76
10	372	2·795	+23·65	1·0	+0·73	−0·59	−0·69
11	373	3·008	+28·76	1·2	+0·91	−0·54	−0·81
12	373	3·436	+32·80	0·9	+0·85	+0·54	+0·41
13	373	3·635	+32·50	0·6	+2·30	+2·93	+3·05
					$\Sigma pv^2 = 47·7$	35·0	34·2

Preliminary elements were selected by trial and corrected by least-squares. The result of this solution is indicated in the residuals under headings $(O–C)_1$ and $(O–C)_2$. The reduction in Σpv^2 is satisfactory, but on computing the residuals from the observation equations they were found to differ from those computed from the ephemeris. To show the magnitude of the changes in the elements and indicate the degree of uncertainty which attaches to them, the two sets are given below.

	1st.	2nd.
P	$=$ 3·854 days	3·854 days
T	$=$ J.D. 2,420,370·55	2,420,370·375
e	$=$ 0·10	0·030
ω	$=$ 105°	89°·05
K	$=$ 25 km.	24·60 km.
γ	$=$ +7·65 km.	+ 8·24 km.

The main change is in the eccentricity, which was greatly over-estimated, in the preliminary elements. In proceeding to a second solution ω was put at 90 degrees, and a small change made in T to correspond. The eccentricity was made $0\cdot05$, and the solution again carried through. The normal equations using Schlesinger's notation are:

$$\begin{aligned}
10\cdot200\Gamma + 0\cdot808\kappa - 1\cdot249\pi + 0\cdot705\epsilon - 0\cdot652\tau &= -1\cdot586\\
+4\cdot863\kappa - 0\cdot774\pi + 0\cdot299\epsilon - 0\cdot719\tau &= +1\cdot114\\
+5\cdot337\pi + 0\cdot182\epsilon + 4\cdot765\tau &= +0\cdot352\\
+1\cdot300\epsilon + 0\cdot209\tau &= +0\cdot425\\
+4\cdot285\tau &= +0\cdot190
\end{aligned}$$

whence,

$$\begin{aligned}
\tau &= -5\cdot54 & dT &= -\ \cdot125\\
\epsilon &= +0\cdot44 & de &= -\ \cdot008\\
\pi &= +5\cdot037 & d\omega &= -11\cdot73\\
\kappa &= +0\cdot174 & dK &= +\ \cdot174\\
\Gamma &= +0\cdot063 & d\gamma &= -\ \cdot19
\end{aligned}$$

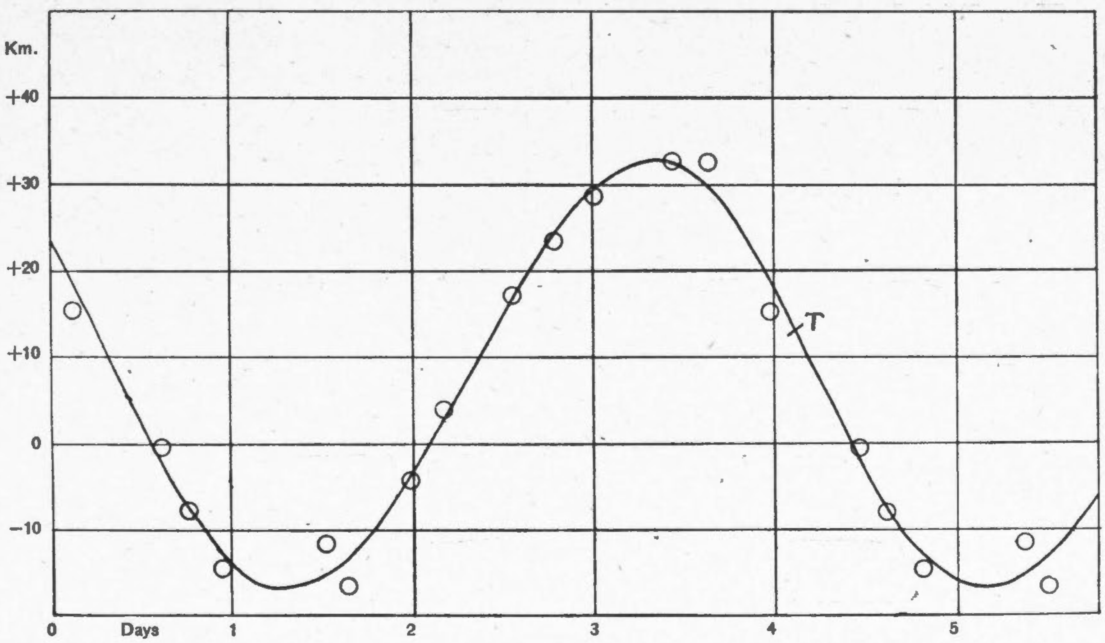
and the final elements with the probable errors become,

P	$= 3\cdot854$ days	
e	$= 0\cdot042$	$\pm\ \cdot025$
T	= J. D. 2,420,370·259	$\pm\ \cdot351$ day
ω	$= 78°\cdot27$	$\pm\ 21°\cdot9$
K	$= 24\cdot77$ km.	$\pm\ \cdot70$ km.
γ	$= +7\cdot81$ km.	
$a \sin i$	= 1,312,000 km.	
$\frac{m_1^3 \sin^3 i}{(m+m_1)^2}$	$= 0\cdot0061\odot$	

The residuals from these elements agree with the residuals from the observation equations to the nearest tenth of a kilometre. Comparison with the residuals given by the first solution shows that little has been gained, and the differences between the last two sets of elements are less than the probable errors.

The residuals given by the individual plates are tabulated under the heading (O–C) in the table of observations. The probable error of a single observation is $3\cdot7$ km.

Dominion Observatory
Ottawa
May, 1917.



Radial Velocity Curve of π Arietis

PUBLICATIONS
OF THE
DOMINION OBSERVATORY
OTTAWA, CANADA
Vol. IV, No. 5

ORBIT OF THE SPECTROSCOPIC BINARY BOSS 5996

BY REYNOLD K. YOUNG, Ph.D.

Boss 5996 ($\alpha = 23^h\ 13^m\cdot 7$, $\delta = +41°\ 13'$, mag. 5·90, type A) was announced as a binary by Adams in the *Publications of the Astronomical Society of the Pacific*, June, 1916. The following orbit has been computed from measures of forty spectrograms secured by the writer with a one-prism spectrograph attached to the 15-inch telescope.

Numerous metallic lines are present in the spectrum of this star, but on the plates taken here they are rather wide and diffuse, so that accurate measures of individual lines are impossible. The number of lines which can be utilized makes up for this lack to a certain extent. Table I gives the wave-lengths of all the lines measured, together with the mean residuals formed by taking the velocity as given by the plate from the velocities given by the lines. The total weight of each line is also given. The algebraic residuals can be used to correct the wave-lengths in the first column, and the arithmetic residuals give a general idea of the accidental error of setting on the lines and, indeed, if desired may be used to compute the probable error of measurement of the average plate.

The journal of observations follows in Tables II and III. The large range of the observed velocities defines the velocity curve pretty well, and the elements can be determined without any special difficulty.

TABLE I

Wave-length	Arithmetic Residual	Algebraic Residual	Weight	Wave-length	Arithmetic Residual	Algebraic Residual	Weight
4005·602	7·0	−2·2	9	4308·085	7·8	−1·6	7
4045·871	7·9	−1·6	21	4314·661	4·0	−4·0	3
4063·702	10·9	−1·6	13	4325·818	9·3	−3·8	16
4071·612	3·9	−3·8	4	4340·634	6·4	+3·8	4
4077·632	7·8	+7·0	6	4352·001	10·5	−1·2	19
4128·211	3·2	+0·1	2	4374·974	7·7	0·0	32
4143·736	9·5	−5·8	18	4395·202	6·7	+1·6	18
4198·579	10·5	+6·6	12	4415·163	5·5	−0·7	4
4202·139	6·2	−1·0	16	4444·062	9·7	−9·7	6
4215·644	7·1	+2·7	23	4481·454	8·4	−0·1	38
4227·257	8·3	−2·3	10	4501·371	8·4	−0·2	21
4233·462	9·7	+2·5	14	4508·668	10·4	+8·8	10
4236·062	2·8	+1·1	4	4515·508	7·4	+7·4	1
4247·071	6·1	+3·9	12	4522·908	8·8	−2·5	8
4250·659	7·6	+1·3	17	4534·281	8·9	−1·0	17
4260·694	4·6	−2·8	3	4549·737	7·4	+0·7	38
4271·588	6·5	+0·3	19	4558·692	2·0	−2·0	1
4282·746	2·0	−2·0	1	4564·105	2·0	−2·0	1
4290·045	5·4	+2·7	30	4572·202	8·0	−2·8	21
4294·326	5·0	+5·0	4	4583·801	9·5	−2·0	14

TABLE II

MOUNT WILSON OBSERVATIONS OF BOSS 5996

Date	Julian Day	Velocity	O–C
		km.	km.
1914, Oct. 30	2,420,436·714	−86	−13
1915, Dec. 15	847·706	+ 4	−10

TABLE III

OTTAWA OBSERVATIONS OF BOSS 5996

Plate	Date	Julian Day	Phase from 2,421,058·0	Velocity	Weight	O–C
	1916			km.		km.
7732	July 13	2,421,058·816	0·816	− 1·9	1	−4·7
7736	" 14	059·819	1·819	+63·8	1	+2·2
7739	" 17	062·712	1·492	+68·3	1	−1·2
7748	" 20	065·830	1·391	+68·2	1	+2·2
7751	" 22	067·788	0·130	−66·4	1	+4·3
7754	" 23	068·722	1·064	+35·1	1	0·0
7759	" 25	070·647	2·989	−83·6	½	−9·3
7768	Aug. 1	077·690	0·373	−53·0	½	−1·0
7774	" 6	082·596	2·060	+46·6	0	....
7776	" 10	086·847	3·091	−79·7	1	−3·4
7780	" 14	090·635	0·440	−39·5	1	−5·5
7786	" 15	091·794	1·599	+66·4	1	−4·2
7789	" 16	092·635	2·440	−16·9	1	+3·1
7797	" 23	099·560	2·926	−72·5	½	−1·4
7798	" 23	099·633	2·999	−70·3	½	+3·9
7805	Sept. 9	116·785	0·834	+ 4·5	1	−0·5
7809	" 11	118·774	2·823	−61·6	1	+2·9
7814	" 15	122·802	0·412	−48·6	1	−0·6
7817	" 25	132·605	0·557	−29·8	1	−1·7
7818	" 25	132·707	0·659	−18·2	1	0·0
7824	" 30	137·795	2·527	−27·2	1	+4·7
7828	Oct. 1	138·510	0·023	−73·7	1	+1·2
7830	" 1	138·674	0·187	−69·4	1	−1·7
7838	" 2	139·791	1·304	+55·7	1	−4·3
7849	" 4	141·642	3·155	−77·7	1	−1·4
7856	" 6	143·503	1·796	+59·2	1	−4·0
7865	" 9	146·590	1·660	+77·0	1	+7·2
7881	" 29	166·531	2·288	+ 7·7	½	+4·7
7882	" 29	166·613	2·370	−19·8	½	−10·4
7890	Nov. 5	173·480	2·798	−63·5	1	−1·0
7896	" 7	175·585	1·684	....	....	....
7898	" 14	182·573	2·232	+ 9·5	1	+1·0
7905	" 20	188·637	1·857	+58·3	1	+0·3
7921	Dec. 3	201·510	1·852	+53·6	1	−5·4
7922	" 3	201·573	1·915	+51·6	1	−1·6
7923	" 3	201·678	2·020	+34·3	0	....
7941	" 16	214·512	1·976	+44·3	1	−1·7
7963	" 25	223·445	1·251	+63·1	1	+7·6
7967	" 29	227·478	2·069	+40·0	1	+6·5
	1917					
7986	Jan. 12	241·455	3·162	−75·3	1	+1·0
7993	" 16	245·464	0·732	−11·4	1	−2·4

MEASURES OF BOSS 5996

λ	7732		7736		7739		7748		7751		7754		7759	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005·602			+43·6	½	+46·2	½								
4045·871			+47·0	½			+52·7	½	−81·0	½				
4063·702			+56·0	½	+66·3	½					− 4·5	½		
4077·632			+48·6	½										
4143·736			+36·0	½							+ 7·2	½		
4198·579			+46·3	½			+34·2	½	−77·6	½				
4202·139	−37·8	½							−83·7	½	+13·0	½		
4215·644	− 9·5	½	+50·7	½			+57·9	½	−91·2	½	+10·9	½	−106·5	½
4227·257											+19·6	½		
4233·462					+59·9	½								
4247·071									− 90·1	½				
4250·616	−24·5	½	+42·7	½			+51·6	½					−104·3	½
4260·694													−112·1	½
4271·588			+34·0	½					−88·3	½	+12·6	½		
4282·746											+12·8	½		
4290·045			+47·8	½	+51·1	½	+40·8	½	− 85·9	½	+14·3	½		
4308·085	−21·1	½			+27·2	½								
4325·939			+44·6	½							− 1·6	½		
4340·634							+48·3	½	− 87·4	½				
4352·001							+58·3	½	−104·6	½	+35·9	½		
4374·974	−27·0	½	+26·6	½	+61·4	½	+52·7	½	− 81·9	½			−112·6	½
4395·202	−21·2	½	+29·1	½	+44·4	½			− 81·0	½				
4415·163	−30·5	½			+46·9	½					+24·3	½		
4481·454	−36·0	½	+47·5	½	+51·9	½	+40·7	½	−102·1	½	+18·8	½	− 95·9	½
4501·371					+44·9	½					+32·9	½	−109·3	½
4508·668											+14·8	½		
4522·908	− 6·1	½			+30·9	½								
4534·281	−17·0	½												
4549·737	−23·6	½	+37·2	½	+35·9	½	+43·1	½	− 75·2	½			− 92·2	½
4558·692											+12·8	½		
4564·105											+12·8	½		
4572·202			+46·1	½	+47·4	½	+43·4	½	− 85·2	½			− 96·5	½
Weighted mean	− 23·12		+ 42·74		+ 47·26		+ 47·61		− 86·80		+ 14·79		−103·67	
V_a	+ 21·47		+ 21·39		+ 21·13		+ 20·79		+ 20·55		+ 20·43		+ 20·16	
V_d	+ 0·08		+ 0·07		+ 0·19		+ 0·03		+ 0·10		+ 0·17		+ 0·22	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 1·9		+ 63·9		+ 68·3		+ 68·2		− 66·4		+ 35·1		− 83·6	

MEASURES OF BOSS 5996—*Continued*

λ	7768		7774		7776		7780		7786		7789		7797	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4045·871					−117·7	½			+36·0	½	−32·9	½		
4063·702					−108·9	½			+51·1	½				
4071·612					− 97·0	½								
4077·632					− 88·5	½								
4143·736									+53·3	½				
4202·139									+57·7	½	−33·2	½		
4215·644	−68·7	½							+59·8	½	−23·8	½		
4227·257					− 81·4	½					−48·4	½		
4233·462					−104·6	½					−19·9	½		
4247·071									+49·1	½				
4250·659							−62·3	½	+62·1	½	−45·5	½		
4260·694							−53·0	½						
4271·588					− 95·6	½					−23·1	½		
4290·045	−68·0	½					−49·6	½			−34·5	½		
4308·085					−100·1	½								
4325·818			+20·2	½	− 82·9	½	−48·4	½			−18·3	½		
4352·001					−106·8	½	−72·2	½	+35·6	½				
4374·974	−57·1	½	+16·9	½	−102·6	½	−58·2	½					−90·6	½
4395·202							−63·4	½	+54·9	½			−85·7	½
4444·066									+46·4	½			−89·6	½
4481·454	−72·2	½			− 84·6	½	−46·0	½	+55·0	½	−23·6	½	−71·4	½
4501·371	−94·7	½									−26·5	½	−88·5	½
4508·668	−43·6	½					−48·0	½			−40·4	½		
4522·908	−87·2	½												
4534·281	−85·7	½												
4549·737			+45·0	1	− 77·8	½	−54·3	½	+54·2	½	−42·5	½	−91·5	½
4572·202					−100·7	½			+44·1	½	−41·5	½		
4583·801			+16·3	½										
Weighted mean	− 72·15		+ 28·68		− 96·37		− 55·54		+ 50·84		− 32·44		− 86·22	
V_a	+ 19·00		+ 18·02		+ 17·07		+ 16·15		+ 15·87		+ 15·65		+ 13·74	
V_d	+ 0·18		+ 0·22		− 0·09		+ 0·19		− 0·04		+ 0·19		+ 0·23	
Curv.	± 0·00		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 53·0		+ 46·6		− 79·7		− 39·5		+ 66·4		− 16·9		− 72·5	

MEASURES OF BOSS 5996—*Continued*

λ	7798		7805		7809		7814		7817		7818		7824	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005·602	...	...	−10·4	½	...	...	−44·5	½	−42·3	½	− 9·1	½	−29·1	½
4045·871	...	...	−13·9	½	...	...	−44·4	½	−27·2	½	−12·2	½	−21·4	½
4063·702	...	...	− 9·0	½	...	...	...	...	−39·0	½	−19·8	½	−24·2	½
4071·612	...	...	− 3·1	½	...	...	...	...	−32·9	½	...	...	−41·0	½
4077·632	...	...	+ 8·2	½	−71·3	½	...	...	...	...	...	...	...	...
4143·736	...	...	0·0	½	−78·0	½	...	...	...	...	−15·4	½	− 9·6	½
4198·579	...	...	...	...	...	...	...	...	−22·7	½	− 6·1	½	...	...
4202·139	...	...	− 2·0	½	...	...	−55·5	½	−26·7	½	−36·2	½	−25·8	½
4215·644	...	...	− 5·4	½	−84·1	½	−68·7	½	−20·7	½	−27·9	½	...	...
4227·257	...	...	− 6·2	½	−66·9	½	...	...	...	...	−11·8	½	−27·1	½
4233·462	...	...	+ 8·1	½	...	...	...	...	...	...	−33·3	½	...	...
4236·062	...	...	− 6·7	½	...	...	−50·4	½	...	...	...	...	...	...
4247·071	...	...	...	...	...	...	...	...	−24·4	½	−24·2	½	...	...
4250·659	...	...	− 8·3	½	−66·0	½	−35·0	½	−23·4	½	...	...	...	...
4271·588	...	...	...	...	−64·8	½	...	...	−32·3	½	−22·1	½	−18·3	½
4290·045	...	...	+ 8·9	½	...	...	−62·1	½	−29·1	½	−17·5	½	−12·3	½
4294·326	...	...	...	...	−64·7	½	...	...	...	...	...	...	...	...
4314·661	...	...	− 3·7	½	...	...	...	...	−43·0	½	−20·8	½	...	...
4325·818	...	...	...	...	−70·1	½	...	...	−41·6	½	−26·1	½	−43·9	½
4340·634	...	...	...	...	...	...	...	...	−21·4	½	...	...	...	...
4352·001	...	...	...	...	...	...	...	...	−42·7	½	−23·4	½	−26·8	½
4374·974	−77·8	½	+ 7·7	½	−57·1	½	−45·5	½	−23·1	½	−17·9	½	−26·4	½
4395·202	...	...	+ 6·9	½	...	...	...	...	−42·3	½	− 3·7	½	...	...
4415·163	...	...	...	...	...	...	...	...	...	...	...	...	−31·6	½
4444·066	...	...	...	...	...	...	...	...	...	...	...	...	−54·9	½
4481·454	−92·1	½	−15·4	1	−61·6	1	−58·5	½	−25·4	½	− 7·3	½	−23·6	½
4501·371	...	...	− 5·0	½	...	...	−58·7	½	...	...	−13·2	½	−32·8	½
4508·668	...	...	...	...	...	...	...	...	−16·9	½	− 8·7	½	...	...
4522·908	...	...	...	...	−61·5	½	...	...	...	...	−24·9	½	−33·3	½
4534·281	...	...	− 2·9	½	...	...	−59·2	½	−37·8	½	−33·3	½	−24·9	½
4549·737	−84·3	½	− 2·7	1	−67·4	½	−68·7	½	−37·3	½	− 8·5	½	−25·6	½
4572·202	−103·0	½	...	...	−75·2	½	...	...	...	...	−28·2	½	−24·9	½
4583·801	− 62·4	½	...	...	−81·4	½	−53·3	½	−27·9	½	−33·2	½	−41·8	½
Weighted mean	− 83·92		− 3·32		− 68·77		− 54·20		− 31·92		− 20·17		− 27·15	
V_a	+ 13·71		+ 8·19		+ 7·50		+ 6·03		+ 2·38		+ 2·34		+ 0·41	
V_d	+ 0·18		− 0·11		− 0·11		− 0·15		+ 0·03		− 0·10		− 0·19	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 70·3		+ 4·5		− 61·6		− 48·6		− 29·8		− 18·2		− 27·2	

MEASURES OF BOSS 5996—*Continued*

λ	7828		7830		7838		7849		7856		7865		7881	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4045·871					+59·8	½	−72·7	½	+67·7	½	+59·3	½	+13·0	½
4077·632							−72·6	½						
4128·211					+59·8	½					+67·2	½		
4143·736	−71·2	½	−66·5	½			−92·4	½	+41·3	½				
4198·579					+70·8	½					+85·9	½	+38·1	½
4202·139	−81·1	½							+63·1	½			+17·3	½
4215·644							−69·8	½	+70·1	½				
4227·257													+ 3·1	½
4233·462	−77·9	½			+59·1	½	−81·9	½	+65·4	½				
4247·071	−67·6	½			+63·5	½	−71·9	½			+78·5	½		
4250·659											+58·9	½		
4271·588					+47·9	½			+71·9	½				
4290·045	−70·7	½	−71·3	½	+58·7	½	−61·0	½	+66·8	½	+82·5	½	+25·9	½
4294·326													+22·8	½
4308·085							−72·8	½	+52·0	½				
4352·001					+58·2	½	−85·8	½					+24·2	½
4374·974	−79·6	½			+55·2	½	−75·5	½	+50·4	½			+ 5·3	½
4395·202			−57·7	½					+52·6	½				
4444·066							−83·5	½			+76·7	½		
4481·454	−67·9	½	−87·2	½	+53·1	½	−76·5	½	+40·0	½	+80·5	½	+15·1	½
4501·371	−75·7	½	−87·2	½	+45·9	½	−70·7	½			+86·0	½		
4508·668	−72·0	½	−62·0	½	+61·2	½	−56·9	½						
4522·908							−75·3	½					+15·5	½
4534·281	−63·1	½	−66·3	½	+78·4	½	−96·0	½						
4549·737	−84·3	½	−62·9	½	+51·6	½	−68·6	½	+87·4	½	+98·5	½	+20·2	½
4572·202			−74·6	½	+50·7	½	−84·5	½	+64·6	½	+96·4	½		
4583·801			−64·6	½	+48·3	½	−96·1	½	+61·7	½	+92·4	½		
4325·818			−59·5	½										
4340·634							−61·9	½						
Weighted mean	− 73·74		− 69·09		+ 56·51		− 76·32		+ 61·07		+ 80·23		+ 18·23	
V_a	+ 0·12		+ 0·05		− 0·37		− 1·08		− 1·79		− 3·00		− 10·31	
V_d	+ 0·19		− 0·04		− 0·19		± 0·00		+ 0·18		+ 0·07		+ 0·07	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 73·7		− 69·4		+ 55·7		− 77·7		+ 59·2		+ 77·0		+ 7·7	

MEASURES OF BOSS 5996—*Continued*

λ	7882		7890		7898		7905		7921		7922		7923	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4045·871			−45·5	½					+70·7	½	+60·0	½		
4063·702			−48·3	½			+64·5	½						
4143·736			−53·3	½			+65·6	½	+60·3	½	+60·6	½		
4198·579							+95·1	½						
4215·644	− 2·4	½			+30·2	½	+89·9	½						
4233·462					+23·0	½	+97·3	½	+59·7	½	+92·3	½		
4236·062									+77·5	½				
4247·071	+ 4·6	½					+76·4	½						
4250·659	−13·0	½							+72·9	½				
4260·694									+71·7	½				
4271·588	+ 5·2	½	−56·0	½	+16·4	½			+67·4	½	+57·7	½		
4290·045	−14·3	½			+20·9	½	+76·9	½	+85·6	½	+81·3	½		
4308·085							+87·6	½			+76·5	½		
4325·818					+ 9·5	½	+64·0	½						
4352·001	−11·5	½	−48·6	½					+87·0	½	+55·2	½		
4374·974	−25·9	½	−50·9	½			+79·2	½	+66·2	½	+85·7	½		
4395·202	−11·9	½	−50·8	½	+26·1	½			+84·7	½				
4444·066			−62·5	½										
4481·454	−22·3	½			+37·7	½	+47·2	½	+81·5	½	+71·2	½	+46·4	½
4501·371			−46·3	½	+38·8	½			+85·1	½	+72·9	½		
4515·508									+81·5	½				
4534·281			−53·5	½							+90·0	½		
4549·737	− 0·7	½	−49·3	½	+16·3	½	+67·5	½	+59·6	½	+72·7	½	+63·5	½
4583·801	− 7·9	½	−42·8	½										
4572·202					+37·6	½								
Weighted mean	− 9·10		− 50·65		+ 25·65		+ 75·92		+ 74·09		+ 72·17		+ 54·95	
V_a	− 10·35		− 12·68		− 16·04		− 17·13		− 20·14		− 20·15		− 20·16	
V_d	− 0·07		+ 0·11		− 0·07		− 0·18		− 0·06		− 0·14		− 0·22	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 19·8		− 63·5		+ 9·3		+ 58·3		+ 53·6		+ 51·6		+ 34·3	

MEASURES OF BOSS 5996—*Concluded*

λ	7941		7963		7967		7986		7993					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005·602	...	...	...	...	+47·2	½	...	...	+ 6·3	½	...	...	...	...
4045·871	...	...	...	...	+67·1	½	...	...	+ 0·5	½	...	...	...	...
4063·702	+69·0	½	...	...	+57·1	½	...	...	...	...	...	...	...	...
4077·632	...	...	...	...	+78·4	½	...	...	...	...	...	...	...	...
4143·736	+47·2	½	...	...	+53·1	½	...	...	− 0·1	½	...	...	...	...
4198·579	...	...	...	...	+52·6	½	−49·1	½	+14·6	½	...	...	...	...
4202·139	+81·8	½	+92·0	½	+48·5	½	...	...	...	...	...	...	...	...
4215·644	+69·2	½	+87·9	½	+66·9	½	...	...	+10·8	½	...	...	...	...
4227·257	+57·3	½	...	...	+53·4	½	...	...	...	...	...	...	...	...
4233·462	...	...	...	...	+60·7	½	...	...	...	...	...	...	...	...
4236·062	...	...	...	...	+63·8	½	...	...	...	...	...	...	...	...
4247·071	+88·4	½	+83·6	½	...	...	...	...	...	...	...	...	...	...
4250·659	+74·5	½	+93·9	½	+76·7	½	...	...	...	...	...	...	...	...
4271·588	+72·6	½	+89·9	½	+66·3	½	...	...	...	...	...	...	...	...
4290·045	+66·2	½	+79·1	½	+60·7	½	−41·1	½	+ 8·9	½	...	...	...	...
4294·326	...	...	...	...	+63·7	½	...	...	+21·6	½	...	...	...	...
4325·818	+54·2	½	...	...	+69·9	½	−52·2	½	+ 5·1	½	...	...	...	...
4340·634	...	...	...	...	+57·2	½	...	...	...	...	...	...	...	...
4352·001	+58·8	½	...	...	+87·5	½	...	...	+20·0	½	...	...	...	...
4374·974	+82·1	½	+77·5	½	+59·0	½	...	...	+13·6	½	...	...	...	...
4395·202	...	...	+89·3	½	...	...	...	...	...	...	...	...	...	...
4481·454	+70·9	½	+91·6	1	+72·7	½	−58·1	½	+24·6	½	...	...	...	...
4501·371	...	...	...	...	+48·9	½	−38·6	½	...	...	...	...	...	...
4534·281	+53·6	½	+78·9	½	+68·5	½	−57·5	½	...	...	...	...	...	...
4549·737	+72·8	½	+76·7	½	+62·5	½	−55·9	½	+ 3·2	½	...	...	...	...
4572·202	+46·9	½	...	...	+70·9	½	−68·9	½	...	...	...	...	...	...
Weighted mean	+ 66·59		+ 86·00		+ 63·06		− 52·68		+ 10·76		...		...	
V_a	− 21·92		− 22·56		− 22·67		− 22·21		− 21·77		...		...	
V_d	− 0·11		− 0·04		− 0·11		− 0·12		− 0·16		...		...	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		...		...	
Radial Velocity	+ 44·3		+ 63·1		+ 40·0		− 75·3		− 11·4		...		...	

NORMAL PLACES

—	Julian Day	Phase from J.D. 2,421,058	Velocity	Weight	O–C Preliminary	O–C Final
1	2,421,058	0·158	−67·90	1·0	+0·21	+1·41
2	058	0·399	−50·07	0·8	−1·65	−0·56
3	058	0·498	−34·65	1·0	+3·02	+3·94
4	058	0·696	−14·80	1·0	−1·74	−1·35
5	058	0·825	+ 1·30	1·0	−2·87	−2·92
6	059	1·064	+35·10	0·5	−0·06	−0·56
7	059	1·278	+59·40	1·0	+1·80	+1·53
8	059	1·442	+68·25	1·0	+0·09	+0·18
9	059	1·630	+71·70	1·0	+1·03	+1·47
10	059	1·808	+61·50	1·0	−0·97	−0·62
11	059	1·875	+54·50	1·5	−2·33	−2·03
12	060	2·022	+42·15	1·0	+1·93	+1·54
13	060	2·251	+ 8·90	0·8	+1·94	+0·42
14	060	2·461	−21·60	1·2	+3·27	+1·15
15	060	2·810	−62·55	1·0	+1·93	+0·57
16	060	2·971	−75·46	1·0	−1·94	−2·45
17	061	3·123	−78·70	1·0	−2·61	−2·32
18	061	3·202	−74·50	1·0	+0·69	+1·37
				$\Sigma pv^2 =$	71·0	56·9

The observations were grouped into eighteen normal places, as given above, and from these preliminary elements were obtained by trial. In correcting the preliminary elements, Schlesinger's notation and form for the differential coefficients were adopted and found very satisfactory. The steps in the solution follow.

PRELIMINARY ELEMENTS

$$
\begin{aligned}
P &= 3{\cdot}2195 \text{ days} \\
T &= \text{J.D. } 2{,}421{,}059{\cdot}945 \\
e &= 0{\cdot}05 \\
\omega &= 45^\circ \\
K &= 73{\cdot}6 \text{ km.} \\
\gamma &= -5{\cdot}10 \text{ km.} \\
\mu &= 111^\circ{\cdot}819
\end{aligned}
$$

NORMAL EQUATIONS

$$
\begin{array}{llllll}
17{\cdot}8\Gamma & -0{\cdot}278\kappa & -0{\cdot}382\pi & +4{\cdot}249\epsilon & +0{\cdot}239\tau & =1{\cdot}201 \\
 & 9{\cdot}899\kappa & +1{\cdot}232\pi & -0{\cdot}150\epsilon & +1{\cdot}148\tau & =0{\cdot}369 \\
 & & +7{\cdot}901\pi & -0{\cdot}454\epsilon & +7{\cdot}133\tau & =6{\cdot}828 \\
 & & & +2{\cdot}691\epsilon & -0{\cdot}261\tau & =3{\cdot}579 \\
 & & & & +6{\cdot}479\tau & =6{\cdot}134
\end{array}
$$

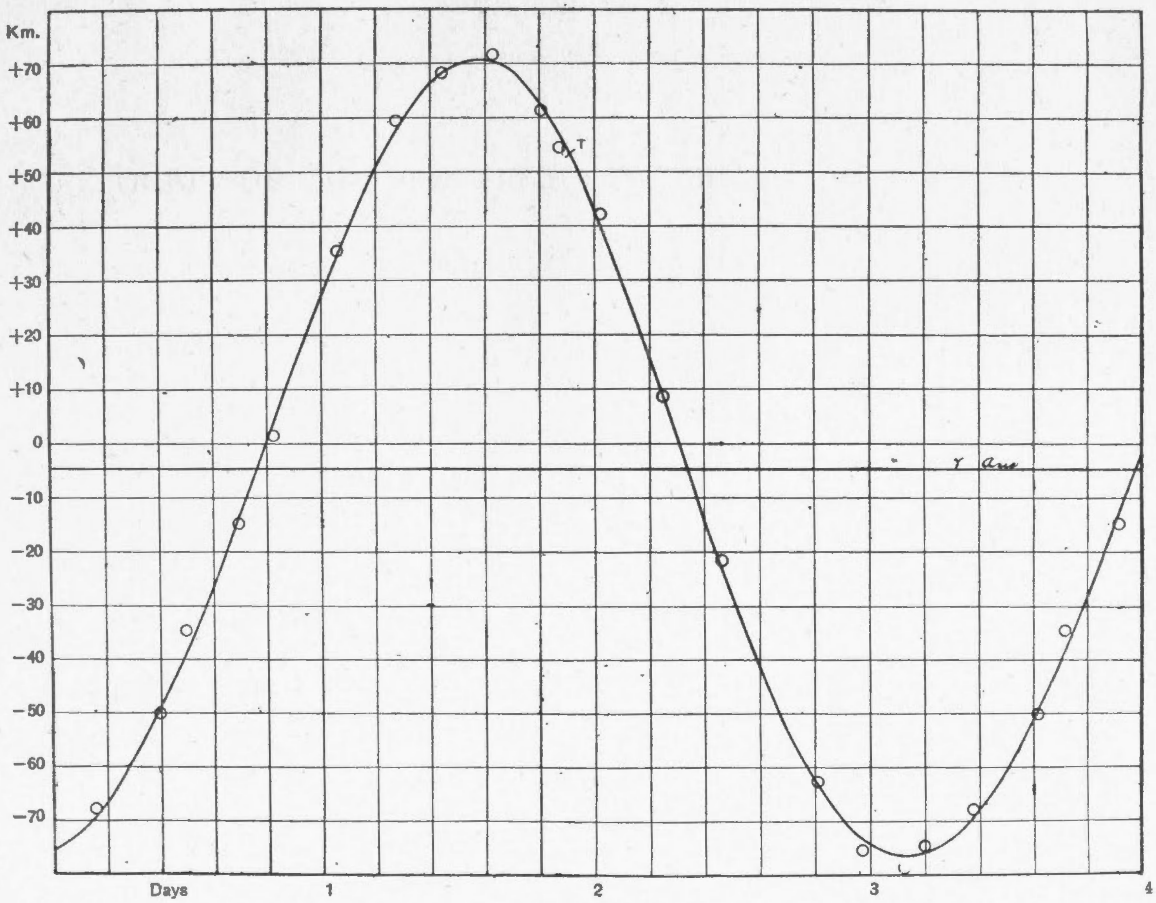
$$
\begin{array}{lll}
\tau = -\ 5{\cdot}210 & dT = -\ 0{\cdot}033 \text{ day} & \pm{\cdot}064 \\
\epsilon = +\ 2{\cdot}207 & d\omega = -\ 4^\circ{\cdot}43 & \pm 7^\circ{\cdot}13 \\
\pi = +\ 5{\cdot}688 & de = -\ 0{\cdot}0135 & \pm{\cdot}0067 \\
\kappa = -\ 0{\cdot}04 & dK = -\ 0{\cdot}04 \text{ km.} & \pm 0{\cdot}45 \text{ km.} \\
\Gamma = -\ 0{\cdot}27 & d\gamma = +\ 0{\cdot}23 \text{ km.} &
\end{array}
$$

FINAL ELEMENTS

$$
\begin{aligned}
P &= 3{\cdot}2195 \text{ days} & \\
T_s &= \text{J.D. } 2{,}421{,}059{\cdot}912 & \pm{\cdot}064 \text{ day} \\
\omega &= 40^\circ{\cdot}57 & \pm 7^\circ{\cdot}13 \\
e &= {\cdot}0365 & \pm{\cdot}0067 \\
K &= 73{\cdot}56 \text{ km.} & \pm 0{\cdot}45 \text{ km.} \\
\gamma &= -4{\cdot}87 \text{ km.} & \\
a \sin i &= 3{,}240{,}000 \text{ km.} & \\
\frac{m_1^3 \sin^3 i}{(m+m_1)^2} &= {\cdot}133 \odot &
\end{aligned}
$$

The probable error of a single plate, computed from the residuals which result from the above elements, is 2·5 kilometres.

Dominion Observatory
Ottawa
May, 1917.



Radial Velocity Curve of Boss 5996

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 6

ORBIT OF THE SPECTROSCOPIC BINARY 40 AURIGÆ

BY REYNOLD K. YOUNG, Ph.D.

Forty Aurigæ ($\alpha = 5^h\ 59^m.6$, $\delta = +38°\ 29'$, mag. 5·31, type A) was announced as a spectroscopic binary by Lee in the *Astrophysical Journal*, Vol. XXXIX, 1914. The following discussion of the orbit is based on measures of the three plates given there, and fifty-three taken here with a one-prism spectrograph attached to the 15-inch telescope.

TABLE I

λ	λ	λ	λ
4005·402	4202·118	4294·270	4481·462
4030·766	4215·744	4307·979	4501·503
4033·092	4233·421	4325·907	4508·455
4045·974	4236·001	4340·669	4520·430
4063·706	4250·698	4351·990	4522·909
4071·862	4260·579	4395·287	4534·140
4101·891	4271·643	4404·928	4549·747
4143·789	4282·585	4415·213	4558·990
4191·672	4290·119	4468·870	4572·143
4198·719	4077·885		

Table I gives the wave-lengths of the lines used in reducing the measures. They are the same as those found for the binary Groombridge 1149 and seem to suit the present spectrum very well. The journal of observations follows in Table II. The residuals given in this table under O–C were determined graphically from the final curve. The weights are those used in the least-square solution.

TABLE II

Plate	Observer*	Date	Julian Day	Phase from 2,420,462	Primary			Secondary		
					Velocity	Weight	O–C	Velocity	Weight	O–C
Yerkes	....	1913, Oct. 2	2,420,043·924	6·124	−58·5	.....	+ 4	+130·8	.....	+16
"	....	" 3	44·892	7·092	−35·6	.....	+13	+ 92·9	.....	+ 3
"	....	" 6	47·897	10·097	+22·8	.....	.....	.....	.....	.....
6601	Y	1914, Dec. 5	2,420,472·855	10·855	+19·1	.....	.....	.....	.....	.....
6606	H	" 6	473·753	11·753	+17·9	.....	.....	.....	.....	.....
6610	Y	" 10	477·908	15·908	+21·0	.....	.....	.....	.....	.....
6629	Y–H	" 15	482·727	20·727	+21·0	.....	.....	.....	.....	.....
6645	Y	" 17	484·823	22·823	+20·2	.....	.....	.....	.....	.....
6657	C	" 23	490·632	0·352	+21·1	.....	.....	.....	.....	.....
6661	Y	" 25	492·663	2·383	+18·0	.....	.....	.....	.....	.....
6668	Y	" 30	497·622	7·352	−42·2	1	0	+ 91·1	½	+ 3
6673	Y	" 31	498·719	8·439	+ 5·4	.....	.....	.....	.....	.....
6704	Y	1915, Jan. 10	508·688	18·408	+20·4	.....	.....	.....	.....	.....
6727	Y	" 23	521·802	3·242	+12·4	.....	.....	.....	.....	.....
6732	Y	" 24	522·664	4·104	− 9·5	1	+ 5	+ 72·3	½	+15
6745	P[1]	" 27	525·755	7·195	−48·1	1	− 2	+ 92·4	½	− 1
6751	Y	" 28	526·775	8·215	+ 3·2	.....	.....	.....	.....	.....
6762	P	" 30	528·678	10·118	+15·2	.....	.....	.....	.....	.....
6768	C–P[1]	Feb. 3	532·710	14·150	+25·2	.....	.....	.....	.....	.....
6806	C	" 19	548·567	1·727	+18·0	.....	.....	.....	.....	.....
6811	P	" 20	549·711	2·871	+12·8	.....	.....	.....	.....	.....
6814	Y	" 21	550·597	3·757	+ 0·4	.....	.....	.....	.....	.....
6884	H	Mar. 22	579·618	4·498	−24·8	½	0	+ 75·4	¼	+ 7
6887	Y	" 23	580·563	5·443	−51·2	1	+ 1	+ 91·1	½	− 9
6938	Y	April 20	608·549	5·149	−42·5	1	+ 2	+ 89·4	½	0
6946	C	" 21	609·594	6·194	−67·8	½	− 5	+108·0	¼	− 6
7226	Y	Sept. 9	750·864	6·064	−66·4	½	− 3	+109·7	¼	− 4
7324	Y	Oct. 9	780·872	7·792	−26·3	1	+ 4	+ 80·2	½	+ 6
7330	H	" 10	781·731	8·651	+ 6·7	.....	.....	.....	.....	.....
7336	C	" 11	782·832	9·752	+13·6	.....	.....	.....	.....	.....
7374	Y–C	Nov. 3	805·747	4·387	−23·7	1	− 4	+ 59·9	½	− 4
7383	Y	" 6	808·804	7·444	−43·4	1	− 3	+ 85·1	½	− 1
7438	Y	Dec. 2	834·919	5·279	−48·6	1	− 1	+ 93·6	½	− 1
7439	Y	" 2	834·957	5·317	−54·7	1	− 6	+100·2	½	+ 4
7441	Y	" 3	835·625	5·985	−64·6	1	− 3	+116·2	½	+ 2
7444	C	" 3	835·814	6·174	−67·2	1	− 4	+108·6	½	− 5
7466	H	" 30	862·637	4·717	−33·2	1	− 2	+ 71·1	½	− 4
7467	H–Y	" 30	862·695	4·775	−27·2	1	+ 5	+ 72·5	½	− 4
7497	C	1916, Jan. 28	891·729	5·529	−49·3	1	+ 5	+ 99·2	½	− 4
7498	C	" 28	891·776	5·576	−54·2	1	+ 1	+ 95·7	½	− 8
7524	C	Feb. 28	922·566	8·086	−20·8	½	+ 2	+ 77·0	¼	+11
7525	C	" 28	922·622	8·142	−23·2	½	+ 1	+ 64·4	¼	− 3
7526	C	" 28	922·678	8·198	−23·3	½	+ 1	+ 63·7	¼	− 4
7576	Y–P	Mar. 25	948·520	5·760	−56·0	1	+ 3	+115·2	½	+ 6
7787	Y	Aug. 15	2,421,091·853	7·693	−34·5	1	0	+ 70·3	½	− 7
7810	Y	Sept. 11	118·849	6·409	−55·6	1	+ 6	+115·4	½	+ 4
7811	Y	" 11	118·896	6·456	−57·6	1	+ 4	+117·0	½	+ 6
7873	Y	Oct. 11	148·741	8·021	−25·4	1	− 1	+ 58·6	½	−10
7924	Y	Dec. 5	203·670	6·390	−63·8	1	− 1	+121·2	½	+10
8074	Y	1917, Feb. 27	287·553	5·453	−50·9	1	+ 2	+ 91·0	½	−10
8081	Y	Mar. 1	288·497	7·397	−42·0	1	− 1	+ 84·8	½	− 3
8083	Y	" 1	288·615	7·515	−43·7	1	− 5	+ 87·2	½	+ 4
8084	Y	" 1	288·679	7·579	−39·3	1	− 1	+ 82·6	½	+ 2

*P=Plaskett; H=Harper; C=Cannon; P[1]=Parker; Y=Young

MEASURES OF 40 AURIGÆ

λ	6601		6606		6610		6629		6645		6657		6661	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	......		+17·9	½	+18·9	½	+25·6	½	+20·4	¼	+20·4	½	+25·8	½
4024	......		......		......		......		......		+21·6	½	......	
4030	+14·9	½	......		+20·5	½	......		......		+20·1	½	......	
4045	+ 5·3	½	+ 5·3	½	+15·1	½	+22·2	½	+11·5	¼	+19·5	½	+16·0	½
4063	+14·5	½	+18·1	½	......		+ 8·2	½	+11·8	¼	+21·7	1	+19·9	½
4071	......		......		+10·2	½	......		......		......		......	
4077	+ 3·8	½	+11·9	½	+13·7	½	......		+15·5	¼	+22·8	½	+15·5	½
4143	+ 8·1	1	+11·0	½	......		......		......		+16·7	½	......	
4202	......		......		......		......		......		+27·4	½	+23·3	½
4215	+11·2	½	+14·3	½	......		+12·2	½	+32·7	¼	+16·3	1	+26·7	½
4233	+12·1	½	......		......		......		......		+19·4	½	+19·9	½
4250	......		......		+16·3	½	......		......		+16·3	½	+ 4·8	½
4260	+11·6	½	+ 3·1	½	......		......		......		+30·3	½	+21·2	½
4271	+13·5	½	+ 3·8	½	......		+23·1	½	+23·1	¼	......		+16·1	½
4282	......		......		......		......		......		......		+25·8	½
4289	+ 7·6	½	− 0·2	½	+14·2	1	+ 4·1	½	+14·2	¼	+27·9	1	+22·8	½
4294	......		......		......		......		......		+25·1	½	......	
4325	+ 4·4	½	......		......		+17·8	½	......		......		+17·8	½
4340	......		......		+27·0	½	......		......		+28·1	½	......	
4352	+ 5·6	½	+13·7	½	......		......		......		+22·8	½	+13·6	½
4404	+13·0	½	......		......		......		......		......		......	
4415	+18·9	½	......		......		......		......		......		......	
4468	......		......		......		......		......		+25·8	½	......	
4481	+17·1	1	+23·3	½	+10·2	½	+25·8	½	......		+28·1	½	+23·8	½
4501	+21·7	½	......		......		......		......		+12·8	½	+28·4	½
4508	+12·8	½	......		......		......		......		......		......	
4522	+ 0·2	½	+ 9·2	½	......		......		......		+18·2	½	......	
4534	......		......		......		......		......		+24·7	½	......	
4549	+ 2·6	½	+ 3·9	½	+13·0	½	+24·9	½	......		+19·7	½	+18·3	½
4572	+26·6	½	+11·9	½	......		......		......		......		......	
Weighted mean	+ 11·35		+ 10·50		+ 15·75		+ 18·21		+ 18·46		+ 21·98		+ 19·98	
V_a	+ 8·20		+ 7·76		+ 5·71		+ 3·27		+ 2·22		− 0·74		− 1·79	
V_d	− 0·15		− 0·12		− 0·21		− 0·18		− 0·15		+ 0·11		+ 0·07	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 19·1		+ 17·9		+ 21·0		+ 21·0		+ 20·2		+ 21·1		+ 18·0	

54043—2

MEASURES OF 40 AURIGÆ—*Continued*

λ	6668				6673		6704		6727		6732			
	Primary		Secondary								Primary		Secondary	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	−42·0	½	+99·1	½			+46·9	¼	+35·8	½				
4030											+ 7·2	½	+78·7	¼
4045	−34·6	½	+97·6	¼	+ 5·3	½	+28·4	½						
4063	−46·8	¼	+80·3	¼					+21·7	½	− 0·8	¼	+68·6	¼
4071	−38·9	¼	+98·3	¼										
4077	−37·4	½	+89·5	½	+ 0·9	½	+26·5	½	+21·9	½	+14·6	½		
4143	−30·6	¼	+98·0	¼										
											− 6·8	½	+95·4	¼
4198	−42·4	½												
4202					+16·7	¼			+36·5	½				
4215					+15·3	¼	+26·6	½	+28·7	½				
4250							+26·4	½	+24·8	½				
4260											+ 3·2	¼	+ 77·6	¼
4271	−34·8	½	+99·3	¼			+26·9	½	+26·3	½	+13·0	½	+115·3	¼
4289	−34·8	½	+96·7	½			+38·1	½	+29·4	½				
4308	−31·6	½									+19·1	¼	+97·4	¼
4325					+ 5·5	¼			+22·3	½				
4340									+22·5	½				
4352							+31·9	½	+45·6	½				
4481					+28·4	¼	+38·4	½	+28·4	½				
4501							+23·0	½						
4522							+32·4	½						
4534					+11·7	¼	+28·6	½	+28·6	½				
4549	−45·9	¼	+97·1	½	+15·7	¼			+26·2	½				
4572									+32·0	½				
Weighted mean	− 37·66		+ 95·61		+ 10·57		+ 30·49		+ 28·71		+ 7·05		+ 88·83	
V_a	− 4·32		− 4·32		− 4·82		− 9·80		− 15·79		− 16·16		− 16·16	
V_d	+ 0·10		+ 0·10		− 0·06		− 0·08		− 0·21		− 0·07		− 0·07	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 42·2		+ 91·1		+ 5·4		+ 20·4		+ 12·4		− 9·5		+ 72·3	

MEASURES OF 40 AURIGÆ—*Continued*

λ	6745				6751		6762		6768		6806		6811	
	Primary		Secondary											
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt
4005	−30·9	½					−30·7	1	+55·5	½	+56·3	½	+48·7	½
							−33·2	1			+49·0	½		
4045	−34·6	½					−31·0	1	+40·8	½	+41·2	1	+33·3	1
4063	−28·8	½					−32·6	½			+40·7	½		
4077	−20·1	½	+ 94·0	¼	+10·0	½	−34·7	½			+39·3	½	+43·8	½
4143	−27·7	½	+116·4	¼			−33·2	1	+51·6	½	+43·8	½	+40·0	½
4198					+20·4	½			+43·5	½	+34·4	½	+37·5	1
4202							−51·7	½			+46·1	1		
4215	−33·6	½	+123·0	¼			−36·8	1	+50·8	½			+50·2	½
4233					+10·1	¼					+39·7	½		
4250							−23·7	½	+34·2	½	+49·1	½	+28·5	½
4260							−29·7	½						
4271	−40·2	¼	+103·6	¼			−33·9	1			+39·2	½	+29·6	½
4289							−34·9	1	+55·3	½	+41·3	½	+31·6	1
4308			+107·4	¼			−38·9	½						
4325							−13·4	½						
4340					+28·2	½	−48·7	1			+42·8	½		
4395													+40·1	½
4481					+25·8	½	−34·6	1	+42·8	½			+56·6	¼
4501					+16·6	¼								
4522	−30·7	½	+117·4	¼	+36·0	¼								
4534							−28·6	½					+30·5	½
4549					+26·2	¼	−24·9	½					+43·3	½
4572							−45·3	½	+37·3	½			+49·3	½
Weighted mean	− 30·20		+110·30		+ 21·50		+ 34·16		+ 45·76		+ 43·31		+ 38·60	
V_a	− 17·44		− 17·44		− 17·85		− 18·59		− 20·12		− 25·03		− 25·32	
V_d	− 0·19		− 0·19		− 0·21		− 0·10		− 0·18		− 0·03		− 0·21	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 48·1		+ 92·4		+ 3·2		+ 15·2		+ 25·2		+ 18·0		+ 12·8	

MEASURES OF 40 AURIGÆ—*Continued*

λ	6814		6884				6887				6938			
			Primary		Secondary		Primary		Secondary		Primary		Secondary	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005							−23·8	½	+125·6	¼	−16·1	½	+107·6	¼
4030			+ 9·2	½							−20·1	¼		
4045	+22·2	½	+ 1·7	½			−20·4	½			−15·1	½		
4063	+11·8	½	− 3·5	½							−16·4	½	+120·5	½
4077	+27·4	½	+14·6	½	+125·1	¼	−21·9	½	+107·7	½	−15·1	¼		
4143	+29·3	½	+10·5	¼			−18·0	½	+139·6	¼	−19·0	½	+116·4	½
4215			+ 9·2	¼	+ 99·4	¼	−19·1	1	+122·0	½				
4260			− 7·5	¼	+103·0	¼	−36·2	½	+ 92·4	¼	−23·5	¼	+ 98·8	¼
4271							−16·6	½	+124·0	½				
4289	+39·0	½					−17·0	½	+122·4	¼	−19·7	½	+124·5	¼
4325			− 6·7	¼	+ 90·3	¼								
4340	+32·6	½					−21·1	½			−11·4	½		
4415							−23·9	½	+133·2	¼				
4522							−18·0	½	+128·3	¼				
4549	+22·3	½					−30·2	½	+115·8	½				
Weighted mean	+ 26·37		+ 4·13		+104·45		− 21·95		+120·37		− 16·92		+114·97	
V_a	− 25·53		− 28·50		− 28·50		− 28·84		− 28·84		− 25·05		− 25·05	
V_d	− 0·10		− 0·20		− 0·20		− 0·15		− 0·15		− 0·21		− 0·21	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 0·4		− 24·8		+ 75·4		− 51·2		+ 91·1		− 42·5		+ 89·4	

MEASURES OF 40 AURIGÆ—*Continued*

λ	6946				7226				7324				7330	
	Primary		Secondary		Primary		Secondary		Primary		Secondary			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	−59·1	¼	+116·5	¼	−100·7	¼			−51·7	½				
4045	−49·7	¼	+148·1	¼	−113·9	½			−53·2	½	+43·9	½	−20·0	½
4063					−110·7	½			−52·8	½				
4071									−60·8	½				
4077	−42·9	½	+131·5	¼	− 81·7	½	+75·4	¼	−47·5	½	+64·8	½	−21·0	½
4143	−31·1	¼	+129·4	¼	− 88·5	½	+83·7	½	−48·8	½			−17·9	½
4198	−44·4	½												
4215	−32·9	½			− 97·0	½			−51·8	½	+56·4	½	−25·6	½
4236	−40·5	½											−18·8	½
4260									−65·9	½				
4271					− 87·0	½			−51·0	½			−11·2	½
4289	−55·1	¼			− 86·6	½							−27·2	½
4308									−53·5	½	+46·3	½		
4340	−58·3	¼												
4404													−23·1	½
4415													−23·9	½
4481	−39·2	¼	+141·0	¼	− 86·0	½	+84·8	¼						
4549					− 92·8	½								
4572	−32·8	½											−18·0	½
Weighted mean	− 42·46		+133·30		− 94·16		+ 81·90		− 53·70		+ 52·85		− 20·67	
V_a	− 24·79		− 24·79		+ 27·85		+ 27·85		+ 27·50		+ 27·50		+ 27·45	
V_d	− 0·23		− 0·23		+ 0·22		+ 0·22		+ 0·07		+ 0·07		+ 0·21	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 67·8		+108·0		− 66·4		+109·7		− 26·3		+ 80·2		+ 6·7	

MEASURES OF 40 AURIGÆ—*Continued*

λ	7336		7374				7383				7438			
			Primary		Secondary		Primary		Secondary		Primary		Secondary	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005							−62·0	½	+47·9	½	−51·3	½		
4033			−45·8	½	+44·0	½								
4045	− 8·0	½	−39·5	½	+46·1	¼	−59·9	½			−53·2	½	+ 71·0	½
4063	−10·8	½			+49·6	¼	−61·3	½	+63·4	½	−58·6	½	+ 76·2	½
4071													+ 88·1	½
4077	−10·9	½					−57·5	½	+78·5	½	−42·0	½	+ 75·8	½
4143					+53·7	¼	−64·3	½	+52·2	½				
4191			−45·0	½	+32·0	¼	−69·0	½			−62·0	½	+ 82·0	½
4198	−13·1	½					−72·9	½						
4215	−17·9	½	−49·8	¼			−58·5	½	+66·2	½	−56·3	½	+ 77·6	½
4233											−52·0	½		
4236	−13·6	½												
4260	−19·1	½					−68·0	½	+55·3	½	−73·8	½		
4271	−18·8	½							+81·5	½	−61·2	½		
4289	−10·9	½					−62·6	½	+59·3	½	−70·2	½		
4308											−59·0	½		
4340									+78·0	½	−61·1	½	+ 83·7	½
4352											−52·5	½	+108·0	½
4481			−48·5	½	+18·7	½					−48·8	½	+ 97·6	½
4534	− 9·7	½												
4549	−15·7	½					−65·6	½			−64·3	½		
Weighted mean	− 13·50		− 45·27		+ 38·35		− 63·78		+ 64·70		− 57·76		+ 84·44	
V_a	+ 27·29		+ 21·67		+ 21·67		+ 20·64		+ 20·64		+ 9·67		+ 9·67	
V_d	+ 0·11		+ 0·13		+ 0·13		+ 0·05		+ 0·05		− 0·20		− 0·20	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 13·6		− 23·7		+ 59·9		− 43·4		+ 85·1		− 48·6		+ 93·6	

MEASURES OF 40 AURIGÆ—*Continued*

λ	7439				7441				7444					
	Primary		Secondary		Primary		Secondary		Primary		Secondary			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005					−68·0	½	+113·3	½						
4033	−59·6	½			−64·1	½								
4045	−71·8	½			−72·7	½	+115·6	½	−75·0	½				
4071	−45·4	½	+100·8	½										
4077					−80·0	½	+ 94·4	½	−69·6	½	+ 96·3	½		
4143					−76·4	½	+108·8	½	−66·7	½	+102·5	½		
4215	−64·1	½	+ 91·8	½					−64·1	½				
4236	−77·0				−73·8	½	+117·5	½			+104·5	½		
4250	−73·8	½	+ 79·1	½			+ 96·0	½						
4260	−82·9	½												
4289	−66·4	½			−75·1	½	+100·1	½	−71·3	½	+ 90·0	½		
4308	−49·6	½			−75·6	½			−84·4	½	+ 93·8	½		
4325					−80·5	½								
4340					−56·0	½								
4352					−84·4	½	+106·1	½						
4395					−76·0	½	+111·3	½	−93·9	½	+ 111·4	½		
4481	−40·0	½	+ 95·0	½	−82·1	½	+107·6	½	−84·0	½				
4549	−72·2	½	+ 78·7	½	−68·2	½								
Weighted mean	− 63·89		+ 91·08		− 73·78		+107·07		− 76·12		+ 99·75			
V_a	+ 9·65		+ 9·65		+ 9·33		+ 9·33		+ 9·24		+ 9·24			
V_d	− 0·22		− 0·22		+ 0·12		+ 0·12		− 0·08		− 0·08			
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28			
Radial Velocity	− 54·7		+100·2		− 64·6		+116·2		− 67·2		+108·6			

MEASURES OF 40 AURIGÆ—*Continued*

λ	7466				7467				7497					
	Primary		Secondary		Primary		Secondary		Primary		Secondary			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	−19·7	½	+63·7	½	−20·0	½	+72·5	½	−26·5	½	+129·1	½		
4030					−20·5	½			−34·1	½				
4033									−42·4	½				
4045	−26·2	½	+70·1	½					−35·0	½				
4063	−18·9	½	+81·6	½	−23·0	½	+72·2	½			+105·5	½		
4071	−26·8	½									+ 99·9	½		
4077	−32·5	½	+83·1	½					−28·3	½	+121·4	½		
4101									−15·9	½				
4143	−17·9	½			−29·0	½	+67·7	½	−21·3	½	+123·8	½		
4191	−36·0	½			−14·0	½	+72·0	½	−30·0	½				
4205					−36·6	½								
4215	−25·1	½	+92·3	½					−26·7	½	+108·8	½		
4233					−25·4	½								
4236											+134·8	½		
4250	−20·6	½	+67·0	½	− 9·5	½	+91·8	½	−35·3	½	+111·3	½		
4260	−34·5	½	+74·4	½			+79·7	½			+109·5	½		
4271	−49·3	½	+71·8	½	−26·8	½	+83·7	½	−29·5	½	+ 97·1	½		
4290	−37·0	½							−32·1	½	+119·7	½		
											+ 99·8	½		
									−33·5	½				
									−35·6	½	+135·2	½		
									−37·5	½	+138·3	½		
									−34·1	½	+116·8	½		
Weighted mean	− 28·74		+ 75·50		− 22·75		+ 77·10		− 31·11		+117·40			
V_a	− 4·27		− 4·27		− 4·30		− 4·30		− 17·72		− 17·72			
V_d	+ 0·08		+ 0·08		− 0·02		− 0·02		− 0·18		− 0·18			
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28			
Radial Velocity	− 33·2		+ 71·1		− 27·2		+ 72·5		− 49·3		+ 99·2			

MEASURES OF 40 AURIGÆ—*Continued*

λ	7498				7524				7525					
	Primary		Secondary		Primary		Secondary		Primary		Secondary			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	−32·9	½			− 4·3	½	+108·6	½	+ 0·4	½	+91·3	½		
4030					+15·8	½	+ 85·8	½	+ 6·8	½	+90·7	½		
4033					− 6·1	½								
4045	−43·9	½							+ 9·3	½	+93·1	½		
4063	−39·7	½			+ 9·0	½	+ 95·7	½	0·0	½				
4071					+13·6	½			+ 8·2	½				
4077	−36·5	½	+115·0	½	+ 3·7	½								
4143	−21·3	½	+120·8	½					+ 6·8	½				
4191	−33·5	½	+113·0	½					+11·3	½				
4215	−37·1	½	+118·0	½	+ 6·1	½			+ 7·1	½				
4260	−37·2	½												
4271	−40·8	½	+105·2	½	+14·0	½	+126·9	½						
4290	−30·5	½												
4307	−39·2	½	+105·9	½										
4340	−39·1	½	+102·2	½					− 0·6	½				
4351			+131·1	½					− 6·8	½				
Weighted mean	− 35·97		+113·90		+ 6·47		+104·25		+ 4·15		+ 92·00			
V_a	− 17·74		− 17·74		− 26·93		− 26·93		− 26·94		− 26·94			
V_d	− 0·21		− 0·21		− 0·07		− 0·07		− 0·14		− 0·14			
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28			
Radial Velocity	− 54·2		+ 95·7		− 20·8		+ 77·0		− 23·2		+ 64·4			

MEASURES OF 40 AURIGÆ—*Continued*

λ	7526				7576				7787					
	Primary		Secondary		Primary		Secondary		Primary		Secondary			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005					−32·5	½	+143·6	¼	−63·9	½				
4030					−30·6	½								
4033					−32·9	½								
4045	+ 0·9	½	+ 81·6	¼	−28·8	½	+160·1	¼	−74·6	½	+47·2	½		
4063	+ 5·4	½	+ 84·3	¼	−34·7	½	+108·2	¼	−50·3	½	+52·1	½		
4077	+ 7·3	½			−32·9	½	+121·4	½						
4143					−19·3	½	+149·4	¼	−50·6	½				
4191					−21·5	½								
4202									−67·1	½	+48·5	¼		
4215					−26·7	½								
4233					−22·9	½			−49·1	½				
4250	+ 1·1	½												
4260					−29·8	½			−55·0	½	+53·9	¼		
4271					−17·2	½								
4289					−27·2	½			−79·3	½				
4308					−23·7	½								
4325	0·0	½	+ 85·0	¼										
4340	+19·8	½	+109·0	¼										
4352	− 5·7	½	+ 95·8		−33·7	½	+159·7	¼						
4395							+161·3	¼	−31·6	½				
4481					−18·2	½			−70·3	½	+35·8	¼		
4501									−34·1	½				
4515									−66·4	½				
4534									−41·4	½				
4549					−24·9	½	+150·9	¼	−69·3	½				
Weighted mean	+ 4·11		+ 91·14		− 26·91		+144·32		− 57·36		+ 47·50			
V_a	− 26·95		− 26·95		− 28·73		− 28·73		+ 22·86		+ 22·86			
V_d	− 0·20		− 0·20		− 0·10		− 0·10		+ 0·24		+ 0·24			
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28			
Radial Velocity	− 23·3		+ 63·7		− 56·0		+115·2		− 34·5		+ 70·3			

MEASURES OF 40 AURIGÆ—*Continued*

λ	7810				7811				7873					
	Primary		Secondary		Primary		Secondary		Primary		Secondary			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4045					− 82·1	½	+113·4	¼	−58·3	½	+28·3	¼		
4063	−89·6	½	+ 69·2	¼										
4071									−54·9	½	+28·1	¼		
4143			+ 83·6	¼	− 71·8	½	+ 91·3	¼						
4198	−82·0	½												
4215					− 78·7	½	+ 70·3	¼						
4233	−86·4	½												
4236	−88·6	½	+ 81·9	¼										
4250					−100·8	½								
4260	−78·3	½	+ 88·6	¼	− 83·6	½			−54·5	½	+40·7	¼		
4271	−80·5	½			− 90·2	½			−36·8	½				
4289	−98·7	½	+ 96·2	¼	− 92·3	½	+87·8	¼	−51·3	½	+45·4	¼		
4325					− 88·0	½								
4340					− 88·0	½	+ 73·1	¼						
4351			+ 92·5	¼	− 76·6	½	+ 60·6	¼						
4395							+ 79·5	¼						
4481	−70·3	½	+103·7	¼	− 97·4	½	+104·3	¼	−59·1	½	+15·1	¼		
4501	−81·4	½	+ 76·7											
4549	−86·3	½	+ 87·5	¼	− 75·8	½	+ 96·8	¼						
4572	−77·6	½												
Weighted mean	− 83·61		+ 87·30		− 85·61		+ 88·93		− 52·48		+ 31·52			
V_a	+ 28·13		+ 28·13		+ 28·20		+ 28·20		+ 27·18		+ 27·18			
V_d	+ 0·20		+ 0·20		+ 0·13		+ 0·13		+ 0·21		+ 0·21			
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28			
Radial Velocity	− 55·6		+115·4		− 57·6		+117·0		− 25·4		+ 58·6			

MEASURES OF 40 AURIGÆ—*Continued*

λ	7924				8074				8081					
	Primary		Secondary		Primary		Secondary		Primary		Secondary			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	−73·0	½			−22·2	½	+113·2	¼	−14·1	½	+113·2	¼		
4030	−61·4	½			−26·2	½								
4033			+121·6	¼	−29·4	½								
4045	−71·8	½	+126·8	¼	−27·5	½	+116·2	¼	−16·8	½	+125·5	¼		
4063	−73·9	½			−21·7	½	+105·5	¼						
4071					−13·6	½	+118·5	¼	− 8·6	½	+129·5	¼		
4077	−73·0	½			−23·7	½	+115·5	¼	− 4·6	½	+112·2	¼		
4143	−66·7	½	+105·9	¼	−17·9	½	+127·6	¼						
4198	−75·8	½			−12·1	½								
4215	−62·0	½			−31·8	½	+120·5	¼						
4233	−65·4	½			−13·5	½			−18·0	½	+115·5	¼		
4236	−66·8	½	+114·7	½										
4250	−82·2	½							−20·6	½	+ 92·4	¼		
4260					−23·9	½	+119·0	¼	−25·5	½	+ 96·8	¼		
4271					−27·9	½	+116·0	¼	−22·5	½	+105·6	¼		
4289	−73·9	½	+ 94·0	¼	−31·6	½			−19·0	½				
4308	−89·5	½									+108·1	¼		
4325	−65·9	½	+104·5	¼					− 2·8	½	+106·6	¼		
4351	−71·8	½	+105·3	¼					− 9·1	½	+129·1	¼		
4481	−75·1	½	+124·0	¼					−13·8	½				
4549	−70·9	½	+123·4	¼	−32·8	½	+130·5	¼	−15·7	½				
Weighted mean	− 71·71		+113·35		− 23·72		+118·25		− 14·70		+112·25			
V_a	+ 8·04		+ 8·04		− 26·88		− 26·88		− 27·22		− 27·22			
V_d	+ 0·12		+ 0·12		− 0·06		− 0·06		+ 0·04		+ 0·04			
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28			
Radial Velocity	− 63·8		+121·2		− 50·9		+ 91·0		− 42·0		+ 84·8			

MEASURES OF 40 AURIGÆ—*Concluded*

	8083				8084									
	Primary		Secondary		Primary		Secondary							
λ	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4005	−14·1	½	+104·7	¼	− 8·8	½	+ 92·8	¼						
4045	−14·2	½	+104·3	¼	−18·6	½	+110·0	¼						
4063	− 0·9	½	+113·6	¼	− 2·7	½								
4077	−19·2	½	+111·9	¼	+ 3·6	½	+117·8	¼						
4143	−14·0	½												
4198	−31·4	½			−29·3	½								
4215	−20·0	½	+117·5	¼	−18·0	½	+128·3	¼						
4271	−14·5	½	+133·0	¼	− 5·9	½	+111·5	¼						
4289	−13·6	½	+111·0	¼	−12·0	½	+110·0	¼						
4308	−14·3	½	+112·5	¼	−30·9	½	+113·5	¼						
4325					−20·7	½	+ 98·4	¼						
4340					− 2·3	½								
4481					− 7·5	½								
4549	−19·7	½			− 5·2	½	+109·5	¼						
4236					− 8·3	½								
Weighted mean	− 16·00		+114·81		− 11·54		+110·30							
V_a	− 27·23		− 27·23		− 27·24		− 27·24							
V_d	− 0·15		− 0·15		− 0·22		− 0·22							
Curv.	− 0·28		− 0·28		− 0·28		− 0·28							
Radial Velocity	− 43·7		+ 87·2		−39·3		+ 82·6							

In the majority of the early plates the lines are single, for the shape of the velocity curve is such that plates taken at random stand about one chance in seven of showing the two components far enough apart to be resolved on one-prism spectrograms. The character of the velocity curve was suspected from the first few plates and as soon as the period was approximately determined, a few exposures were made with the slit of the spectrograph narrower than usual in an attempt to see whether the two components could be resolved in the interval, phases twelve to thirty days (cf. curve). This attempt was unsuccessful and so the observations thereafter were confined in general to the narrow limits, phases from two to eleven days.

The problem of determining satisfactory elements presents some difficulties. Ordinarily when two sets of lines are visible on the spectrograms, it is possible to make use of the plates taken near the crossing points of the two curves. Plates were taken at these points and were useful in finding the preliminary elements, but they were not included in the final solution because the shape of the radial velocity curves before and after crossing are very dissimilar. The result is that the final elements rest upon measures of plates where only the two spectra are visible. There can be no doubt that much more determinate elements would result with higher dispersion, but the final elements given are believed to be fairly accurate. This belief is founded not only on the small probable errors, which the least-square solution assigns to the results, but also on the disposition of the velocities where the spectrograms show single lines.

The observations where both components were visible were first grouped into normal places.

NORMAL PLACES

	Julian Date	Phase from J. D 2,420,462	Primary				Secondary			
			Velocity	Weight	(O–C)₁	(O–C)₂	Velocity	Weight	(O–C)₁	(O–C)₂
1.......	2,420,466·245	4·245	−16·60	·8	+2·52	+1·76	+ 66·1	·4	+4·48	+6·26
2.......	466·696	4·696	−29·10	1·0	+1·43	+0·71	+ 72·5	·5	−3·03	−1·28
3.......	467·214	5·214	−45·60	·8	−0·40	−1·04	+ 91·5	·4	−1·92	−0·22
4.......	467·404	5·404	−52·30	1·2	−1·86	−2·46	+ 94·1	·6	−5·72	−4·04
5.......	467·622	5·622	−53·20	1·2	+2·63	+2·13	+103·4	·6	−2·99	−1·45
6.......	468·011	6·011	−65·20	·6	−3·12	−3·35	+114·0	·3	−0·01	+1·13
7.......	468·166	6·166	−65·20	·8	−2·33	−2·27	+114·0	·4	−0·98	−0·06
8.......	468·418	6·418	−59·00	1·2	+2·82	+3·28	+117·9	·6	+4·21	+4·62
9.......	469·213	7·213	−42·00	1·2	+2·42	+4·12	+ 92·1	·6	−0·37	−1·51
10.......	469·484	7·484	−42·10	1·6	−5·44	−3·48	+ 84·9	·8	+1·90	+0·40
11.......	469·742	7·742	−30·40	0·8	−0·90	+1·22	+ 75·2	·4	+0·92	−0·77
12.......	470·094	8·094	−23·60	1·0	−3·05	+0·85	+ 64·5	·5	+1·14	−0·68

The relation

$$\gamma(m_1+m_2)=m_2V_1+m_1V_2$$

was transformed by putting $k=m_1/m_2$ and $y=\gamma(1+k)$ so that it becomes

$$y=V_1+kV_2$$

The twelve normal places for V_1 and V_2 give twelve observation equations to determine y and k. This solution was made and gave

$$k=0\cdot828 \quad y=+31\cdot56$$

or $\gamma=+17\cdot2$ kilometres.

The normal places and the individual observations, where the two components were not separated, were now plotted on cross-section paper as in the radial velocity curve. The value of ω was assumed to be 180° for the primary curve, (*i.e.*) the one showing the smaller amplitude. The determination of e was made by trial. It is an easy matter with King's graphical method to try any given set of elements and as ω is already assumed known, the only remaining elements that need to be varied are K and e.

The following elements were selected.

P = 28·28 days
T = J. D. 2,420,468·20
e = 0·56
ω_1 = 180°
γ = + 17·2 km.
C_1 = − 11·49 km.
C_2 = + 52·31 km.
K_1 = 51·41 km.
K_2 = 62·70 km.

The residuals which result from these elements are given under the heading $(O-C)_1$ in the table of normal places. In making a least-square solution, all the elements save *P* were included and the elements of both curves carried at the same time, so that the twelve normal places yield twenty-four observation equations. The results of the fainter component were given half the weight assigned to the primary.

OBSERVATION EQUATIONS

	x	*y*	*z*	*u*	*v*	*w*	$-n$	Weight
1	1	− ·708	0	+1·015	− ·508	+ ·596	−2·520	·8
2	1	− ·930	0	+ ·912	− ·477	+ ·695	−1·430	1·0
3	1	−1·216	0	+ ·496	− ·388	+ ·725	+ ·400	·8
4	1	−1·318	0	+ ·260	− ·336	+ ·680	+1·860	1·2
5	1	−1·422	0	− ·038	− ·260	+ ·572	−2·630	1·2
6	1	−1·544	0	− ·452	− ·091	+ ·219	+3·120	·6
7	1	−1·560	0	− ·512	− ·016	+ ·040	+2·330	·8
8	1	−1·539	0	− ·434	+ ·105	− ·251	−2·820	1·2
9	1	−1·200	0	+ ·529	+ ·395	− ·729	−2·420	1·2
10	1	−1·050	0	+ ·780	+ ·448	− ·727	+5·440	1·6
11	1	− ·910	0	+ ·928	+ ·482	− ·689	+0·900	0·8
12	1	− ·736	0	+1·009	+ ·506	− ·611	+3·050	1·0
13	1	0	+ ·708	−1·238	+ ·620	− ·727	−4·480	·4
14	1	0	+ ·930	−1·112	+ ·582	− ·848	+3·030	·5
15	1	0	+1·216	− ·605	+ ·473	− ·885	+1·920	·4
16	1	0	+1·318	− ·317	+ ·409	− ·830	+5·720	·6
17	1	0	+1·422	+ ·046	+ ·317	− ·698	+2·990	·6
18	1	0	+1·544	+ ·552	+ ·111	− ·268	+0·010	·3
19	1	0	+1·560	+ ·625	+ ·020	− ·049	+0·980	·4
20	1	0	+1·539	+ ·529	− ·127	+ ·306	−4·210	·6
21	1	0	+1·200	− ·645	− ·481	+ ·889	+0·370	·6
22	1	0	+1·050	− ·951	− ·547	+ ·887	−1·900	·8
23	1	0	+0·910	−1·132	− ·587	+ ·840	−0·920	·4
24	1	0	+ ·736	−1·231	− ·617	+ ·746	−1·140	·5

Where
$$x = d\gamma$$
$$y = dK_1$$
$$z = dK_2$$
$$u = de$$
$$v = 100 d\omega$$
$$w = \frac{100\mu\, dT}{(1-e^2)^{\frac{3}{2}}}$$

The normal equations are

$$\begin{array}{rrrrrrr}
18{\cdot}300x & -14{\cdot}362y & +7{\cdot}180z & +1{\cdot}881u & +0{\cdot}091v & -0{\cdot}034w & +7{\cdot}222=0\\
 & +17{\cdot}876y & 0{\cdot}000z & -3{\cdot}882u & -0{\cdot}049v & -0{\cdot}306w & -5{\cdot}231=0\\
 & & +8{\cdot}933z & -2{\cdot}367u & -0{\cdot}030v & -0{\cdot}189w & +2{\cdot}798=0\\
 & & & +9{\cdot}607u & +0{\cdot}978v & -1{\cdot}485w & +6{\cdot}571=0\\
 & & & & +3{\cdot}031v & -4{\cdot}774w & +9{\cdot}460=0\\
 & & & & & +7{\cdot}809w & -14{\cdot}932=0
\end{array}$$

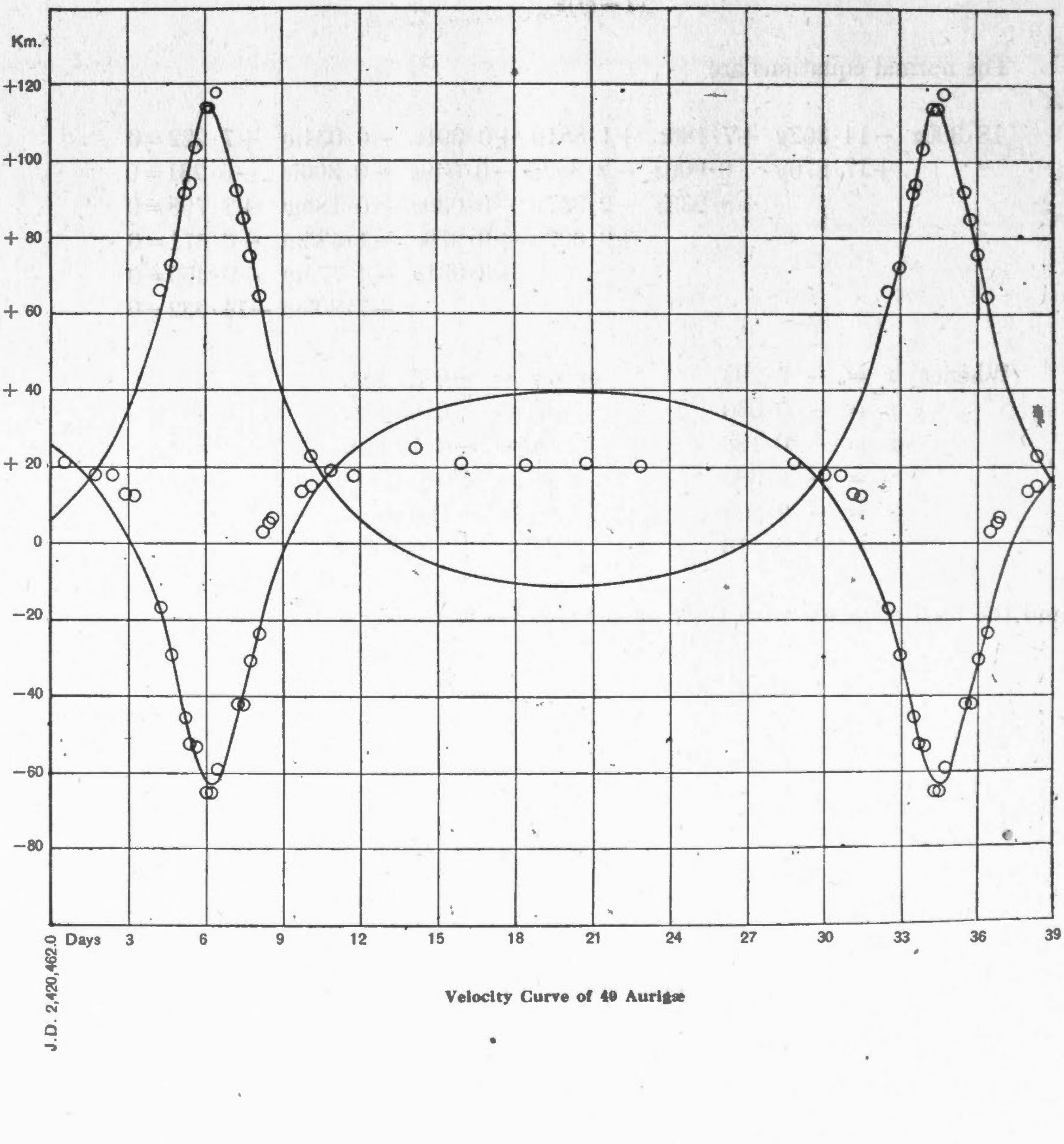
Whence

$$\begin{array}{llll}
x = -0{\cdot}293 & \text{or} & d\gamma = & -0{\cdot}29 \text{ km.}\\
y = -0{\cdot}030 & & dK_1 = & -0{\cdot}03 \text{ km.}\\
z = -0{\cdot}186 & & dK_2 = & -0{\cdot}19 \text{ km.}\\
u = -0{\cdot}380 & & de = & -0{\cdot}0038\\
v = -2{\cdot}808 & & d\omega = & -1^\circ{\cdot}60\\
w = +0{\cdot}116 & & dT = & + {\cdot}003 \text{ day}
\end{array}$$

and the final elements with their probable errors become,

P	$= 28{\cdot}28$ days	$\pm {\cdot}005$ (estimated)
T	= J.D. 2,420,468·197	$\pm {\cdot}088$ day
e	$= 0{\cdot}556$	$\pm {\cdot}0065$
ω_1	$= 178^\circ{\cdot}41$	$\pm 3^\circ{\cdot}1$
ω_2	$= 1^\circ{\cdot}60$	$\pm 3^\circ{\cdot}1$
K_1	$= 51{\cdot}38$ km.	$\pm 1{\cdot}50$ km.
K_2	$= 62{\cdot}51$ km.	$\pm 1{\cdot}64$ km.
γ	$= +16{\cdot}91$ km.	$\pm 1{\cdot}83$ km.
$a_1 \sin i$	= 16,550,000 km.	
$a_2 \sin i$	= 20,140,000 km.	
$m_1 \sin^3 i$	$= 1{\cdot}354 \odot$	
$m_2 \sin^3 i$	$= 1{\cdot}113 \odot$	

Dominion Observatory
Ottawa
May, 1917.



Velocity Curve of 40 Aurigæ

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 7

ORBIT OF THE SPECTROSCOPIC BINARY 29 CANIS MAJORIS

BY W. E. HARPER, M.A.

This star ($\alpha = 7^h\ 14^m$, $\delta = -24° 23'$, vis. mag. 4·77) was announced as a spectroscopic binary* by Professor Frost, director of the Yerkes Observatory, in March, 1906. His results depended chiefly upon $H\gamma$ and the helium line λ 4471, and the four observations gave a range in velocity from − 3 to − 243 km. per second.

In *Harvard Circulars* Nos. 16, 17 and 32, Professor E. C. Pickering called attention to the presence in the spectrum of the lines characteristic of the star ζ Puppis. Miss Cannon has made it the typical star of Class Oe, and a detailed description of its spectrum may be had in *Harvard Annals*, Vol. XXVIII, pages 148−150. It will suffice here to say that, in addition to the regular hydrogen and helium absorption lines and the additional ζ Puppis series of hydrogen absorption lines, there are also emission bands. These in general are not pronounced and, excepting that at λ 4688, would not arrest the attention in a casual glance at its spectrum. The emission line at λ 4633 does not show upon our plates, but there does seem to be an emission band stretching roughly from λ 4647 to λ 4669 and this band appears as though broken by absorption. The absorption line λ 4542 is flanked by emission not only on the red edge, as Miss Cannon states in her description, but on the violet edge as well. Owing to the low altitude of the star (meridional altitude 20°) the plates are not of the best, particularly in the violet region, and it would be worth while at some observatory in the southern hemisphere, where better plates can be secured, to redetermine its orbit. The elements given here are regarded as provisional only.

Observations were commenced on the star in November, 1915, as it was felt that its unfavourable southern declination and poor spectrum would be offset by the large range in velocity. The first plate increased the already large range by showing a velocity of recession of 119 km. per sec. and later plates have further increased the range, so that now this star, so far as the writer is aware, shows the largest range in velocity of any spectroscopic binary yet known.

In our latitude it is necessary that the star be photographed while near the meridian and although it has been kept well in mind during the two seasons since work was com-

*Astrophysical Journal, vol. xxiii, page 265.

menced, yet only 26 plates have been secured in that time. Many of these are not of the best quality, nevertheless, it is felt that a determination of the star's orbit from them will be at least a good approximation.

The lines used for velocity determination have been the absorption lines given in the accompanying table. It was seen from some of the early plates that the ordinary wave-lengths were not suitable, probably owing to their being flanked with emission, and arbitrary values were assumed so as to suit the first few plates measured. These values have been retained, though better values could have been secured by correcting for the residuals given in the table. These residuals are in the sense, mean velocity of plate minus line velocity. While the region around $H\delta$ is generally underexposed and not the most reliable, yet there seems evidence that the wave-length for $H\delta$ must be even greater than the increased value used in the work.

LINES USED IN 29 CANIS MAJORIS

—	No. of Times Used	Weight of Lines	Mean Numerical Residual	Mean Algebraic Residual
4861·527	21	7	22·7	+ 3·7
4713·597	4	$1\frac{3}{4}$	13·3	−13·3
4543·600	25	$10\frac{3}{8}$	14·6	+ 2·9
4471·676	25	$9\frac{1}{4}$	15·4	− 7·4
4340·634	26	10	18·2	+ 5·8
4201·787	3	$1\frac{1}{4}$	14·8	− 1·9
4102·396	8	2	21·9	−12·6
4097·550	3	$\frac{3}{4}$	22·3	− 0·7

MEASURES OF 29 CANIS MAJORIS

λ	7418		7483		7505		7513		7518		7540		7543	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	....	....	+ 3·2	½	....	....	....	....	+181·6	½	−134·6	¼	+221·5	¼
4713	....	....	33·8	¼	....	....	....	....	....	....	....	....	....	....
4543	+82·2	¼	5·2	¼	+126·4	¼	−191·8	⅛	190·8	½	149·5	½	233·0	½
4471	106·9	¼	52·0	¼	93·3	¼	167·7	⅛	214·4	½	120·8	½	234·5	¼
4340	87·3	¼	40·6	½	+ 51·2	¼	−187·7	⅛	188·8	½	−169·5	½	+163·3	¼
4202	+128·5	¼	32·7	½	....	....	....	....	168·6	½	....	....	....	....
4097	....	....	+ 9·8	¼	....	....	....	....	+165·4	½	....	....	....	....
Weighted mean	+101·22		+ 25·36		+ 90·30		−182·40		+184·93		−144·86		+217·04	
V_a	+ 17·95		+ 0·95		− 9·92		− 12·05		− 12·90		− 15·72		− 17·00	
V_d	+ ·04		+ ·04		− ·10		·00		− ·03		− ·04		+ ·03	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+118·9		+ 26·1		+ 80·0		−194·7		+171·7		−160·9		+199·8	

MEASURES OF 29 CANIS MAJORIS—*Continued*

λ	7548		7569		7584		7593		7598		7913		7914	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	−165·2	½	− 33·4	¼	−126·5	½	+187·9	¼	+ 14·7	¼	+179·8	¼	+222·4	¼
4713	172·4	¼	......	......	......	......	......	......	......	......	......	......	......	......
4543	225·8	½	32·2	½	110·9	½	258·9	¾	51·4	¼	187·9	½	178·8	¼
4471	......	......	54·4	½	38·8	½	247·9	½	33·5	⅓	183·4	¼	199·0	½
4340	173·8	¼	71·6	¾	52·5	½	223·4	¾	+ 8·6	⅓	+223·4	½	143·8	¼
4101	126·8	¼	− 52·3	¼	− 57·9	¼	......	......	......	......	......	......	+186·7	¼
4097	−152·3	¼	......	......	......	......	+244·3	¼	......	......	......	......	......	......
Weighted mean	−175·90		− 52·63		− 79·20		+237·56		+ 29·05		+197·67		+188·27	
V_a	− 18·11		− 19·01		− 19·80		− 20·04		− 20·12		+ 17·04		+ 17·04	
V_d	− ·02		− ·02		− ·06		− ·09		− ·08		+ ·09		− ·04	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	−194·3		− 71·8		− 99·3		+217·2		+ 8·6		+214·5		+205·0	

MEASURES OF 29 CANIS MAJORIS—*Continued*

λ	7926		7927		7935		7957		7964		7970		7979	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861			−252·0	¼	− 86·9	¼	−205·5	¼	+ 12·0	½			−174·1	¼
4713									55·8	¾			178·1	½
4543	−151·5	¼	271·9	¼	122·9	¼	204·2	½	28·7	¼	− 68·4	¼	181·2	½
4471	181·1	½	230·3	¼	137·9	¼	196·0	¾	29·4	¾	101·6	½	180·1	½
4340	−176·3	¼	−227·1	¼	−119·8	¼	202·3	½	+ 31·2	½	− 58·6	½	−230·4	¼
4101							174·4	¼						
4097							−151·9	¼						
Weighted mean	−169·63		−245·33		−116·63		−193·28		+ 33·67		− 77·76		−185·35	
V_a	+ 12·24		+ 12·24		+ 11·03		+ 9·45		+ 7·44		+ 6·05		+ 1·75	
V_d	+ ·06		− ·07		·00		+ ·05		·00		+ ·04		− ·04	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	−157·6		−233·4		−106·1		−184·1		+ 40·8		− 72·0		−183·9	

MEASURES OF 29 CANIS MAJORIS—*Concluded*

λ	7984		8006		8019		8024		8058					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	−78·1	¼	−56·6	½	+282·5	¼	−233·5	½	−140·0	¼				
4543	121·0	¾			247·1	¾	191·7	¾	210·0	¼				
4471	135·3	½	72·6	½	230·9	½	159·3	¾	171·8	¼				
4340	93·2	½	−88·8	½	+229·0	½	213·4	¼	180·2	¼				
4101	−152·2	¼					−165·5	¼	−145·2	¼				
Weighted mean	−116·62		−72·67		+242·95		−189·96		−169·44					
V_a	+1·39		−1·89		−5·64		−6·16		−10·76					
V_d	·00		−·04		−·10		−·02		+·02					
Curv.	−·28		−·28		−·28		−·28		−·28					
Radial Velocity	−115·5		−74·9		+236·9		−196·4		−180·5					

YERKES OBSERVATORY MEASURES

Date	Julian Date	Phase	Velocity	Lines	O-C
1906					
Jan. 26	2,417,237·742	1·887	−164	2	+28
Jan. 29	240·744	0·496	− 3	3	− 9
Feb. 12	254·653	1·224	−243	4	−61
Feb. 16	258·622	0·800	− 92	4	+ 3

OTTAWA MEASURES

Plate	Date	Julian Date 2,420,000 +	Phase	Absorption Vel.	Absorption Wt.	Absorption O-C	Emission Vel.	Emission O-C	Character of
	1915								
7418	Nov. 17	0,819·835	3·360	+119	3	+ 9			
	1916								
7483	Jan. 13	0,876·676	3·086	+ 26	4	− 8	+ 62	+28	faint
7505	Feb. 13	0,907·674	3·330	+ 80	2	−20	+102	+ 2	poor
7513	Feb. 20	0,914·645	1·515	−195	3	+ 8	−243	−40	faint
7518	Feb. 23	0,917·604	0·080	+172	6	+ 9			
7540	Mar. 5	0,928·583	2·273	−161	4	−15	−202	−56	
7543	Mar. 11	0,934·509	3·805	+200	4	−12	+169	−43	poor
7548	Mar. 17	0,940·550	1·059	−194	4	−36			
7569	Mar. 23	0,946·524	2·640	− 72	4	+ 4			
7584	Mar. 30	0,953·524	0·853	− 99	3	+11	− 48	+62	pronounced
7593	April 2	0,956·524	3·853	+217	5	− 2	+200	−19	
7598	April 3	0,957·519	0·455	+ 9	3	−16			
7913	Nov. 21	1,189·803	4·282	+214	3	+ 3			
7914	Nov. 21	1,189·869	4·348	+205	4	+ 8	+207	+10	poor
7926	Dec. 10	1,208·763	1·275	−158	2	+30	−153	+35	fair
7927	Dec. 10	1,208·826	1·338	−233	3	−39	−192	+ 2	fair
7935	Dec. 14	1,212·774	0·892	−106	3	+15	− 27	+94	pronounced
7957	Dec. 19	1,217·739	1·464	−184	3	+17	−230	−29	poor
7964	Dec. 25	1,223·741	3·073	+ 41	6	− 9	− 2	−48	good
7970	Dec. 29	1,227·713	2·651	− 72	3	+ 3			
	1917								
7979	Jan. 10	1,239·723	1·481	−184	4	+18			
7984	Jan. 11	1,240·702	2·460	−116	5	− 2			
8006	Jan. 20	1,249·696	2·667	− 75	3	− 5			
8019	Jan. 30	1,259·704	3·888	+237	4	− 5	+255	+23	fair
8024	Feb. 1	1,261·656	1·447	−196	4	+ 5	−206	− 5	
8058	Feb. 15	1,275·596	2·207	−180	3	+ 5	−235	−78	no contrast

The foregoing tables give the data of the observations and are for the most part self-explanatory. The phases are reckoned from the periastron passage finally adopted, using the period 4·3934 days which was arrived at by a comparison of the early observations with our own. While the velocities were carried through to the first decimal place, they are here rounded off as the decimal place has no significance in measures of a spectrum of this type. The probable error of an average plate obtained from columns 6 and 7 of the table is ± 10·0 km. per sec. The probable errors of the elements are, happily, not of corresponding magnitude, thanks to the large range in velocity.

While the emission lines have not been used in the determination, they partake of periodic displacements due to the star's orbital motion just as do the absorption lines.

The velocities quoted are for the line at the assumed wave-length λ 4687·536. It would seem from an examination of the plates, that the centre of this emission band shifts somewhat to the red when the emission is more pronounced. On only one of our plates is the *K* line discernible, and its position would lead one to expect that it does not share the great range in velocity shown by the other lines.

The twenty-six observations were grouped into ten normal places and after preliminary elements were taken, a least-squares solution was carried through giving small corrections to these values and with a reduction of 11 per cent. in the value of Σpvv for the normal places.

These preliminary elements were:

$$P = 4\cdot3934 \text{ days}$$
$$e = \cdot16$$
$$\omega = 40°$$
$$K = 218 \text{ km.}$$
$$\gamma = -12\cdot2 \text{ km.}$$
$$T = \text{J. D. } 2,417,240\cdot259$$

NORMAL PLACES

	Mean Phase	Mean Velocity	Weight	O−C		Mean Phase	Mean Velocity	Weight	O−C
1	0·455	+ 8·6	·3	−15·9	6	2·651	− 71·2	1·0	+4·1
2	0·872	−102·7	·6	+13·0	7	3·078	+ 34·9	1·0	+5·2
3	1·200	−199·2	·9	−19·9	8	3·348	+103·3	·5	−1·2
4	1·474	−189·8	1·4	+11·5	9	3·849	+215·6	1·3	−2·9
5	2·332	−146·9	1·2	− 9·6	10	4·390	+191·8	1·3	+3·0

The Lehmann-Filhés formula was used and making the transformations,

$$x = \delta\gamma$$
$$y = \delta K$$
$$z = K.\delta e$$
$$u = K.\delta\omega$$
$$v = \frac{K}{(1-e^2)^{\frac{3}{2}}} \cdot \mu \cdot \delta T$$

the observation equations were:—

—	x	y	z	u	v	
1.	1·000	+ ·137	−·867	−1·101	+1·219	+ 9·0=0
2.	1·000	− ·504	−·836	− ·882	+ ·784	−19·5=0
3.	1·000	− ·778	−·001	− ·529	+ ·371	+16·4=0
4.	1·000	− ·872	+·626	− ·204	+ ·080	−12·6=0
5.	1·000	− ·553	+·584	+ ·634	− ·520	+14·0=0
6.	1·000	− ·268	−·031	+ ·817	− ·676	+ 0·5=0
7.	1·000	+ ·214	−·835	+ ·893	− ·821	− 0·6=0
8.	1·000	+ ·549	−·993	+ ·802	− ·832	+ 4·1=0
9.	1·000	+1·060	+·116	+ ·247	− ·408	+ 3·2=0
10.	1·000	+ ·908	+·807	− ·723	+ ·834	− 6·2=0

From these observation equations were derived the normal equations:

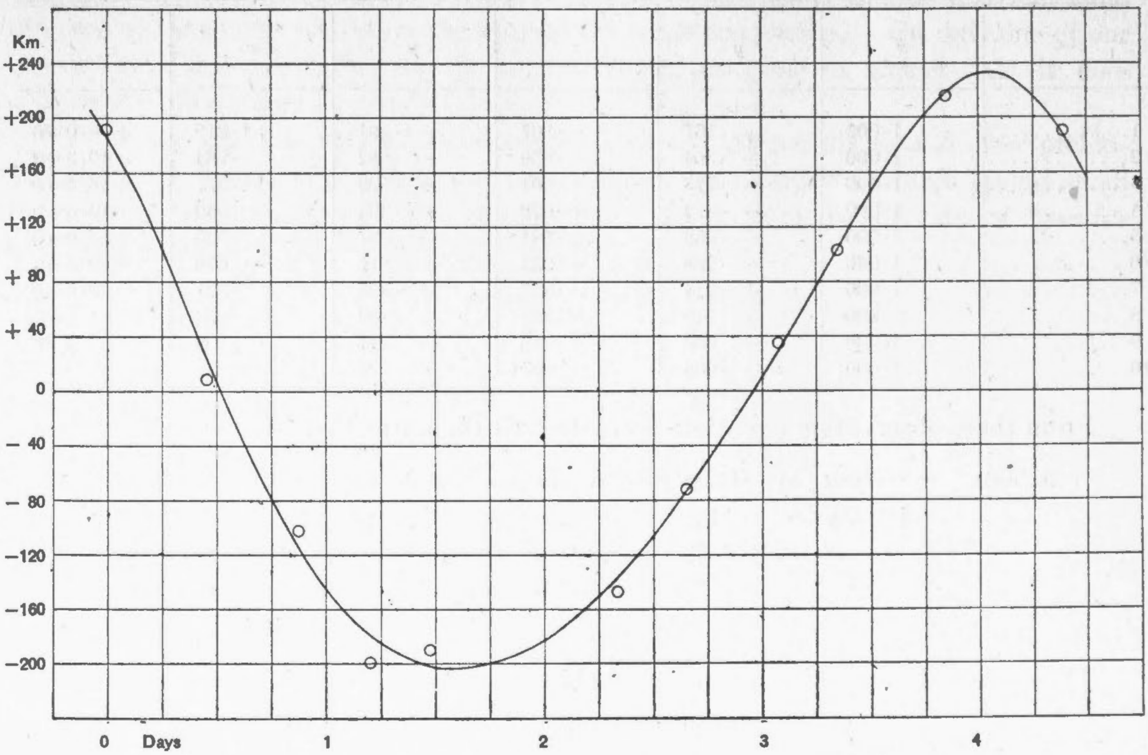
$$9\cdot500x - \cdot088y + \cdot652z + \cdot633u - \cdot702v + 2\cdot970=0$$
$$4\cdot925y - \cdot245z + \cdot122u - \cdot026v - 1\cdot383=0$$
$$3\cdot657z - \cdot898u + \cdot931v - 1\cdot360=0$$
$$4\cdot165u - 3\cdot946v + 22\cdot165=0$$
$$3\cdot868v - 20\cdot494=0$$

The corrected elements, with their probable errors, are then the following:—

$$P = 4\cdot3934 \text{ days}$$
$$e = \cdot156 \quad \pm \cdot017$$
$$\omega = 37^\circ\cdot64 \quad \pm 4^\circ\cdot95$$
$$K = 218\cdot44 \text{ km.} \quad \pm 3\cdot14 \text{ km.}$$
$$\gamma = -12\cdot12 \text{ km.} \quad \pm 2\cdot28 \text{ km.}$$
$$T = \text{J. D. } 2{,}417{,}240\cdot248 \quad \pm \cdot061$$
$$a \sin i = 13{,}035{,}000 \text{ km.}$$
$$\frac{m_1^3 \sin^3 i}{(m+m_1)^2} = 4\cdot58 \odot$$

The curve shown represents the final elements with the observations as grouped.

Dominion Observatory
Ottawa
May, 1917.



Velocity Curve of 29 Canis Majoris

PUBLICATIONS
OF THE
DOMINION OBSERVATORY
OTTAWA, CANADA
Vol. IV, No. 8

ORBIT OF THE SPECTROSCOPIC BINARY [illegible]

BY J. B. CANNON, M.A.

[illegible]

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 8

ORBIT OF THE SPECTROSCOPIC BINARY BOSS 3138

BY J. B. CANNON, M.A.

Boss 3138 ($\alpha = 11^h\ 55^m{\cdot}8$, $\delta = -19°\ 6'$, mag. 5·28, type B3) was announced a spectroscopic binary by Adams from four plates giving a range of 201 km. (*Astrophysical Journal*, Vol. XXXV, p. 176). The lines of the spectrum are very poor, and its declination being far south, it was difficult to secure good plates, and more difficult to secure plates when wanted. The determination of the orbit was based on 31 plates taken in the last two seasons. The period being almost exactly a day and a half had a tendency to bunch the observations at certain points in the orbit. It will be seen by the velocity curve, that the residuals of the normal places are high at points near the zero velocity line. This is due no doubt to the other component, as on several of the plates there was a suggestion of doubling in some of the lines although never distinctly enough seen to make the weaker component measurable. Plate residuals are high, but, considering that on some plates the velocities given by the different lines vary to the extent of as much as 70 km., high residuals are to be expected.

The observations follow; Table I gives Adams' observations, Table II, the Ottawa observations. The residuals are from the final curve.

TABLE I

ADAMS' OBSERVATIONS

Date	Julian Day	Velocity	Residual
1911, Feb. 7·941	2,419,075·940	+ 16	+15·0
Mar. 11·851	107·851	−116	+ 9·5
Mar. 24·843	120·844	+ 85	+ 8·0
April 12·789	139·789	− 21	−26·0

TABLE II

OTTAWA OBSERVATIONS

Plate	Observer*	Date	Julian Day	Phase	Weight	Velocity	Residual
		1916					
7523	H	Feb. 23·760	2,420,917·760	0·182	3	− 39·8	+32·2
7551	C	Mar. 17·719	940·719	0·595	7	+111·5	+12·5
7565	C	Mar. 22·713	945·713	1·080	8	+ 34·4	+12·4
7572	H	Mar. 23·687	946·687	0·551	4	+ 91·6	+ 4·6
7586	Y	Mar. 30·675	953·675	0·023	6	−124·0	− 1·0
7595	Y	April 2·672	956·672	0·014	9	−109·9	+14·1
7608	C	April 10·656	964·656	0·483	6	+ 80·0	+13·0
7611	C	April 14·658	968·658	1·479	5	−121·9	+ 4·0
7615	P	April 15·708	969·708	1·026	3	+ 58·9	+13·4
7618	P	April 19·680	973·680	0·488	2	+ 40·2	+27·8
7625	Y	May 2·606	986·606	1·390	6	−120·7	− 7·7
7633	H	May 4·608	988·608	0·386	4	+ 30·9	+ 4·9
7643	H	May 8·608	992·608	1·379	4	− 81·0	+29·0
7646	Y	May 9·635	993·635	0·904	1	+136·3	+49·3
7664	H	May 24·574	2,421,008·574	0·812	2	+125·9	+20·9
7677	P	May 31·611	015·611	0·333	3	− 74·0	−74·0
7962	C	Dec. 19·965	217·965	1·276	6	− 61·9	+ 9·1
7965	C	Dec. 25·964	223·964	1·263	6	− 65·1	± 0·0
7966	C	Dec. 28·963	226·963	1·256	2	− 66·1	− 4·1
		1917					
8015	C	Jan. 26·948	255·948	0·179	5	−101·3	−26·3
8028	Y	Feb. 1·823	261·823	0·042	3	− 98·8	+21·2
8093	C–H	Mar. 2·734	290·734	0·395	8	+ 57·1	+27·1
8109	C	Mar. 12·699	300·699	1·341	4	−110·7	−13·7
8132	C	Mar. 30·657	318·657	1·262	5	−107·9	−42·9
8137	C	April 3·688	322·688	0·784	7	+117·3	+ 9·3
8145	C	April 16·611	335·611	0·179	6	− 62·2	+12·8
8150	P	April 21·660	340·660	0·719	4	+ 89·8	−20·4
8153	Y	April 22·639	341·639	0·216	3	− 56·7	+ 0·8
8158	Y	April 24·616	343·616	0·712	7	+ 87·8	−22·4
8169	C	May 17·579	366·579	1·086	6	+ 35·1	+15·1
8171	C	May 18·597	367·597	0·601	3	+ 61·0	−37·0

*P=Plaskett; Y=Young; H=Harper; C=Cannon

MEASURES OF BOSS 3138

λ	7523		7551		7565		7572		7586		7595		7608	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481·400			+118·70	¼										
4471·676	−70·00	¼	+108·20	¼			+60·95	¼	−130·20	¼	− 99·10	¼	+ 68·35	¼
4388·100					+ 20·49	¼					−124·40	½	+ 98·00	¼
4340·634	−40·50	¼	+ 83·30	¼	+ 34·83	½	+ 85·90	¼	−129·80	¼	−110·60	¼	+ 68·68	¼
4271·760					+ 30·72	¼							+117·70	¼
4143·928											− 86·00	¼		
4101·890							+146·40	¼	−108·10	¼	−121·30	¼	+ 80·25	¼
4026·352			+116·10	¼	+ 38·35	¼	+ 64·80	¼			−101·30	¼		
Weighted mean	−55·25		+106·58		+31·85		+89·51		−122·70		−107·13		+86·60	
V_o	+15·68		+ 5·23		+ 2·80		+ 2·31		− 1·09		− 2·55		− 6·36	
V_d	+ ·02		± ·00		− ·01		+ ·04		+ ·02		+ ·02		± ·00	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	−39·8		+111·5		+34·4		+91·6		−124·0		−109·9		+80·0	

MEASURES OF BOSS 3138—*Continued*

λ	7611		7615		7618		7625		7633		7643		7646	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4471·676	−153·90	¼	+66·55	¼	+81·62	¼	−129·10	½	+28·82	¼	−74·61	¼	+208·50	¼
4388·100	− 92·90	¼	......		......		−106·80	¼	......		......		......	
4340·634	−112·50	½	+68·64	½	+41·78	¼	− 59·20	¼	+66·00	¼	−50·30	¼	+101·70	¼
4143·928	......		......		+29·90	¼	......		......		......		......	
4101·890	− 95·10	¼	......		......		− 97·90	¼	+49·98	¼	......		......	
Weighted mean	−113·38		+67·94		+51·10		−104·42		+47·93		−62·45		+155·25	
V_a	− 8·23		− 8·70		−10·50		− 15·95		−16·69		−18·17		− 18·54	
V_d	− ·04		− ·11		− ·09		− ·02		− ·04		− ·06		− ·11	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	−121·9		+58·9		+40·2		−120·7		+30·9		−81·0		+136·3	

MEASURES OF BOSS 3138—*Continued*

λ	7664		7677		7962		7965		7966		8015		8028	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481·400	....	....	....	....	− 76·77	¼	....	....	....	....	....	....	....	....
4471·676	+126·40	½	−42·96	½	−109·70	¼	−98·00	¼	−112·80	¼	−158·50	¼	−137·20	¼
4388·100	....	....	−47·78	¼	....	....	−93·00	¼	− 76·40	¼	−111·60	¼	....	....
4340·634	+195·60	¼	....	....	− 50·01	¼	−89·60	¼	....	....	−108·90	¼	−106·80	¼
4143·928	....	....	....	....	−123·90	¼	....	....	....	....	....	....	....	....
4101·890	....	....	−61·18	¼	....	....	....	....	....	....	....	....	....	....
Weighted mean	+149·47		−48·72		−90·10		−93·53		−94·60		−126·33		−122·00	
V_a	− 23·16		−24·83		+28·47		+28·77		+28·79		+ 25·42		+ 23·39	
V_d	− ·09		− ·15		± ·00		− ·04		− ·04		− ·14		+ ·04	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+125·9		−74·0		−61·9		−65·1		−66·1		−101·3		− 98·8	

MEASURES OF BOSS 3138—*Continued*

λ	8093		8109		8132		8137		8145		8150		8153	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481·400	....	....	....	....	−120·70	¼	....	....	....	....	....	....	....	....
4471·676	+31·70	¼	−122·30	¼	....	....	+ 99·42	¼	−59·95	¼	+120·40	¼	−63·45	¼
4388·100	+43·68	¼	....	....	....	....	+119·60	¼	....	....	+ 89·35	¼	−45·80	¼
4340·634	+52·02	½	−114·20	½	− 94·22	¼	+127·30	¼	−51·68	½	+ 94·62	¼	....	....
4143·928	+45·32	¼	....	....	−105·40	¼	+135·70	¼	−70·25	¼	....	....	−24·84	¼
3933·825	....	....	....	....	....	....	....	....	−31·22	¼	....	....	....	....
Weighted mean	+44·95		−118·25		−106·74		+120·50		−52·96		+101·46		−44·70	
V_a	+12·38		+ 7·76		− 0·96		− 2·92		− 9·01		− 11·26		−11·69	
V_d	+ ·06		+ ·07		+ ·06		− ·04		+ ·03		− ·09		− ·03	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+57·1		−110·7		−107·9		+117·3		−62·2		+ 89·8		−56·7	

MEASURES OF BOSS 3138—*Concluded*

λ	8158		8169		8171									
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	+ 46·52	¼												
4481·400	+102·70	¼	+78·93	¼										
4471·676	+140·30	¼	+48·19	¼	+ 93·18	¼								
4388·100	+125·50	¼	+67·30	¼	+108·75	¼								
4340·634	+ 88·22	¼	+35·45	¼	+ 46·48	¼								
Weighted mean	+100·65		+57·47		+82·80									
V_a	− 12·55		−22·02		−21·40									
V_d	± ·00		− ·04		− ·09									
Curv.	− ·28		− ·28		− ·28									
Radial Velocity	+ 87·8		+35·1		+61·0									

The 31 observations were grouped into nine normal places as follows:—

NORMAL PLACES

No.	Julian Day	Phase	Velocity	Weight	Residual
1	2,421,104·371	1·073	+ 38·3	1·0	+12·4
2	247·304	1·266	− 75·5	2·0	− 8·2
3	078·062	1·373	−106·5	1·4	+ 2·1
4	2,420,958·769	0·007	−117·1	2·0	+ 7·7
5	2,421,291·348	0·150	− 84·0	1·7	+ 4·5
6	091·670	0·244	− 56·8	2·0	−11·8
7	100·780	0·429	+ 57·0	1·5	+12·7
8	026·750	0·584	+ 95·0	2·0	− 0·2
9	287·502	0·756	+104·0	1·4	− 6·2

By using the Mount Wilson observations in conjunction with our own, the period was determined with considerable accuracy, viz., 1·50307 days. The other elements of the orbit were obtained by Dr. King's method. They were:—

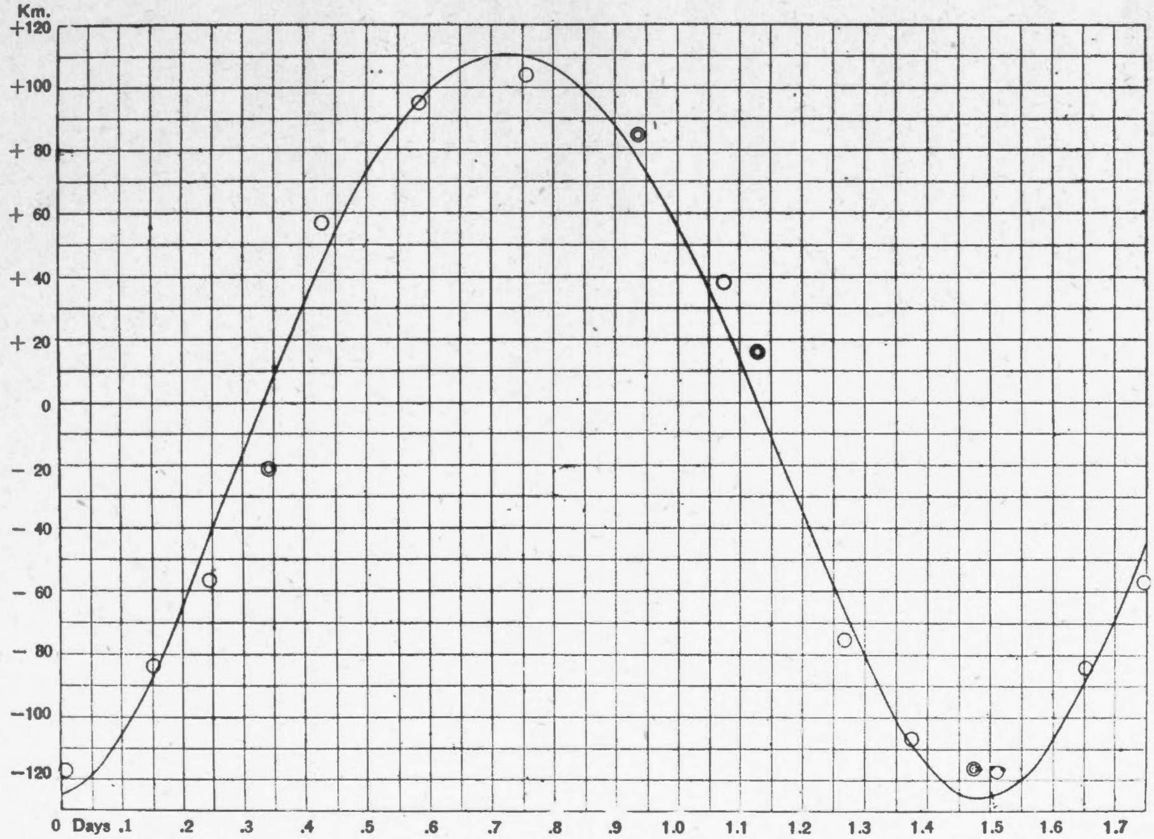
$$K = 115 \text{ km.}$$
$$e = \cdot 05$$
$$\omega = 195^\circ$$
$$T = \text{J. D. } 2{,}420{,}917\cdot 601$$
$$\gamma = -1\cdot 45 \text{ km.}$$

One least-squares solution was carried through, the value of the period being taken as fixed and omitted from the solution. The resulting corrections are small, but the value of Σpvv was reduced about 30 per cent. The corrected values of the elements are given below with the probable errors appended.

$$K = 118\cdot 19 \text{ km.} \quad \pm \cdot 80 \text{ km.}$$
$$e = \cdot 078 \quad \pm \cdot 0082$$
$$\omega = 185^\circ\cdot 08 \quad \pm 9^\circ\cdot 54$$
$$T = \text{J. D. } 2{,}420{,}917\cdot 573 \quad \pm \cdot 038 \text{ day}$$
$$\gamma = +1\cdot 70 \text{ km.} \quad \pm \cdot 72 \text{ km.}$$
$$P = 1\cdot 50307 \text{ days}$$
$$a \sin i = 2{,}435{,}000 \text{ km.}$$
$$\frac{m_1^3 \sin^3 i}{(m+m_1)^2} = 0\cdot 25 \odot$$

Probable error of single plate = ± 13 km.

Dominion Observatory
Ottawa
June, 1917.



Radial Velocity Curve of Boss 3138

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 9

ORBITS OF THE SPECTROSCOPIC COMPONENTS OF [illegible] CASSIOPEIAE

BY W. E. HARPER, M.A.

This star (α = 0h 37m [illegible], δ = +48° 22′) was announced as a spectroscopic binary by Director Frost of the Yerkes Observatory in *Popular Astronomy*, vol. [illegible], page [illegible]. It is of photographic magnitude [illegible] and type [illegible] with the spectra of both components showing.

Thirty-four spectrograms of the star [illegible] 1917 with the [illegible]

PUBLICATIONS
OF THE
DOMINION OBSERVATORY
OTTAWA, CANADA
Vol. IV, No. 9

ORBITS OF THE SPECTROSCOPIC COMPONENTS OF 20 π CASSIOPEIÆ

BY W. E. HARPER, M.A.

This star ($\alpha = 0^h\ 37^m \cdot 9$, $\delta = +46° \ 29'$) was announced as a spectroscopic binary by Director Frost of the Yerkes Observatory in *Popular Astronomy*, vol. 22, page 12. It is of photographic magnitude 5·2 and type A5 with the spectra of both components showing.

Thirty-four spectrograms of the star have been secured at Ottawa in 1916 and 1917 with the single-prism spectrograph, whose linear dispersion at λ4325 is 32·1 Å per millimetre, and from these the orbits of both components have been determined.

The two sets of lines do not differ greatly in intensity, though the lines of what is herein called component I are of slightly better quality for measurement than those of component II. In general, ten or twelve lines were measured for each component. The wave-lengths used in the reduction were those adapted for stars of about similar type, and the elements of the orbit determined from the use of these wave-lengths were given at the Albany meeting of the American Astronomical Society. Since then, in preparing the work for publication, it seemed advisable to revise some of the wave-lengths used, as the algebraic means of their residual velocities were larger than should be expected. When the wave-lengths are so adjusted that the sum of their residuals is zero, no great change may be looked for in the elements resulting from the revised velocities, but these latter should have a somewhat better agreement with the final curve. In the present instance the wave-lengths of the hydrogen lines, the magnesium λ 4481 and some other principal lines were, when revised, all greater than Rowland's or other generally accepted values, and it was decided to lower all values so as to bring these particular ones into conformity with the generally accepted values. This was equivalent to changing the velocity of the system by +3·8 km. per second. This is the only difference of any magnitude, though a few minor changes occur in the other elements principally through dropping all lines used less than five times. The data of the lines are given in the following table which shows the wave-length as revised, how many times the line was measured out of a possible total of 63, the total weight assigned to the line, and the residuals—numerical and algebraic. The latter are taken in the sense, mean velocity of plate minus line-velocity, and refer, of course, to the revised wave-lengths.

LINES IN 20 π CASSIOPEIÆ

Wave-Length	n	Weight	Residual		Wave-Length	n	Weight	Residual	
			Numerical	Algebraic				Numerical	Algebraic
4583·760	8	4½	7·9	−0·1	4260·590	10	3½	12·3	−0·3
4572·257	10	5	12·3	+0·2	4250·551	20	8½	11·4	+1·1
4549·743	44	19¾	10·8	−0·9	4236·032	21	9¼	9·0	+0·5
4534·069	8	4½	10·9	−0·3	4233·394	20	8½	8·4	−1·0
4481·404	50	22¾	11·3	+0·5	4227·211	15	6¼	11·0	−1·0
4415·302	5	2¼	6·9	+1·6	4215·733	9	3¾	7·0	−1·7
4404·780	11	4¼	16·3	+0·4	4202·164	11	4¾	12·6	+0·8
4395·069	7	2¾	7·6	+0·1	4198·677	15	6¾	12·6	−1·1
4351·977	21	8½	11·1	−0·5	4143·731	21	10½	9·5	−0·8
4340·634	47	20¾	11·2	+0·3	4101·898	7	2¼	13·2	+0·8
4325·613	13	5¾	8·6	+0·3	4077·716	13	4¾	11·6	−0·2
4307·974	17	7½	10·3	+1·0	4071·817	8	3¾	13·3	−0·4
4299·748	16	7	12·9	+1·9	4063·666	20	9½	9·8	−1·8
4294·181	10	4½	6·2	+1·2	4045·911	54	25¼	7·6	−0·1
4290·026	25	11½	12·1	0·0	4005·441	22	8	8·2	−0·6
4271·573	41	17¾	9·8	+0·4	3933·681	6	2½	13·9	−0·6

MEASURES OF 20 π CASSIOPEIÆ

Plate	Date		Julian Date	Phase	Component I				Component II			
					n	Wt.	Vel.	O–C	n	Wt.	Vel.	O–C
	1913											
Yerkes	July	21	2,419,970·872	·837	......	......	− 97	+ 1	......	......	+147	+23
"	Aug.	1	9,981·834	·015	......	......	− 42	+26	......	......	+ 90	− 2
"	"	4	9,984·786	1·002	......	......	+ 89	− 1	......	......	− 41	+23
"	Sept.	10	2,420,021·727	·626	......	......	−112	−14	......	......	+143	+19
	1916											
7823	Sept.	30	2,421,137·676	·978	7	·22	+103·2	+ 7·2	11	·14	− 73·2	− 2·2
7831	Oct.	1	1,138·733	·070	10	·22	− 55·9	− 5·0	11	·17	+ 72·8	− 2·0
7837	"	2	1,139·669	1·006	7	·20	+ 86·8	− 1·2	9	·15	− 65·6	− 2·6
7843	"	3	1,140·678	·051	8	·16	− 50·6	+ 6·4	8	·14	+ 85·4	+ 4·6
7848	"	4	1,141·571	·944	7	·22	+108·2	+ 4·0	10	·14	− 74·7	+ 5·0
7854	"	5	1,142·652	·061	9	·17	+ 81·5	+ 4·0	9	·19	− 56·5	− 3·0
7857	"	6	1,143·576	·985	9	·17	− 70·2	− 1·2	9	·15	+ 96·7	+ 2·7
7869	"	11	1,148·492	·009	8	·14	+ 78·5	−14·5	6	·10	− 71·9	− 2·8
7870	"	11	1,148·549	·066	10	·18	+ 61·8	−14·6	10	·16	− 60·0	− 8·0
7878	"	18	1,155·577	1·202	17	·36	+ 8·0	......	......	......	......	......
7879	"	18	1,155·639	1·264	14	·27	+ 14·7	......	......	......	......	......
7889	Nov.	4	1,172·523	·471	15	·25	− 75·0	− 9·6	10	·16	+ 86·6	− 6·2
7902	"	20	1,188·454	·689	7	·14	−119·6	−16·0	7	·13	+123·8	− 5·7
7909	"	21	1,189·522	1·757	15	·30	+128·2	− 1·6	12	·22	− 98·0	+ 8·6
7912	"	21	1,189·730	·001	10	·19	+106·9	+10·9	9	·16	− 74·2	− 2·2
7916	"	22	1,190·541	·812	16	·30	− 98·7	+ 1·9	14	·24	+122·6	− 4·0
7920	"	25	1,193·513	1·820	7	·12	+117·4	− 7·8	4	·06	− 78·5	+22·5
7931	Dec.	14	1,212·548	1·214	21	·51	+ 11·0	......	......	......	......	......
	1917											
7976	Jan.	4	1,233·486	·548	9	·20	− 80·5	+ 4·0	7	·17	+121·8	+10·8
7977	"	6	1,235·454	·552	16	·30	− 80·0	+ 5·0	8	·15	+110·0	− 1·4
7978	"	6	1,235·517	·625	13	·25	− 93·5	+ 3·7	14	·23	+132·1	+ 8·5
7981	"	11	1,240·519	1·689	11	·19	+134·7	+ 5·0	12	·21	−112·4	− 5·8
7982	"	11	1,240·580	1·750	14	·26	+131·3	+ 1·3	10	·16	−112·5	− 6·0
8004	"	19	1,248·453	1·767	8	·15	+141·8	+12·2	9	·16	−110·9	− 4·9
8007	"	22	1,251·454	·840	5	·09	− 90·2	+ 7·4	5	·08	+125·9	+ 2·3
8038	Feb.	10	1,270·473	·217	18	·49	+ 15·2	......	......	......	......	......
8039	"	10	1,270·521	·265	16	·40	+ 9·1	......	......	......	......	......
8069	"	22	1,282·495	·455	10	·22	− 64·5	− 3·5	10	·20	+ 82·9	− 5·1
8234	July	22	1,432·823	1·512	7	·13	+107·1	+ 2·7	4	·06	− 81·4	− 0·4
8239	"	24	1,434·761	1·486	9	·18	+ 97·6	− 0·4	6	·12	− 65·9	+ 9·1
8240	"	24	1,434·829	1·554	8	·16	+121·2	+ 8·0	2	·03	− 98·5	− 7·5
8265	Aug.	10	1,451·715	·763	3	·05	−101·5	+ 2·0	4	·06	+146·5	+16·5
8267	"	11	1,452·683	1·731	10	·15	+132·0	+ 1·6	6	·11	− 90·2	+16·8
8268	"	12	2,421,453·738	·822	7	·14	−102·4	− 2·8	9	·18	+135·3	+10·0

MEASURES OF 20 π CASSIOPEIÆ

λ	7823		7823		7831		7831		7837		7837		7843	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584			−100·8	½										
4549			73·5	¼	−58·1	½	+50·1	½					−53·2	½
4534							57·6	½						
4481			81·1	¾					+ 84·0	¼	−67·9	½		
4351					73·7	¼	66·0	¼						
4340	+ 81·6	½	92·5	½	55·2	½	79·7	¼			70·9	½	75·6	½
4307									59·8	¼	58·7	¼	62·0	½
4300	113·9	½	88·0	¼										
4290									90·4	¼	80·2	¼	71·0	½
4271	59·1	¼	81·6	½	76·4	¼	74·1	½					61·8	¼
4260	91·1	¼	72·2	½	79·2	½	81·1	½						
4250							57·4	¼						
4236	107·9	½							68·1	½				
4233			59·4	½							79·4	½	46·9	½
4227											81·4	¾		
4215					58·7	¼	61·4	½						
4202													22·7	¼
4143									85·7	½	69·7	½		
4077					45·1	¼	67·9	½						
4063			81·7	½	55·5	½								
4045	86·1	¼	90·9	¼	68·0	½	57·0	½	100·6	¼	77·3	½	−53·9	¼
4005	+ 99·5	½	− 80·3	½	−75·8	¼	+66·8	¼	+ 70·8	¼	−66·1	½		
Weighted mean	+ 94·77		− 81·56		− 64·12		+ 64·88		+ 79·20		− 73·22		− 57·63	
V_a	+ 8·61		+ 8·61		+ 8·22		+ 8·22		+ 7·87		+ 7·87		+ 7·49	
V_d	+ ·06		+ ·06		− ·03		− ·03		+ ·05		+ ·05		+ ·03	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 103·2		− 73·2		− 55·9		+ 72·8		+ 86·8		− 65·6		− 50·4	

MEASURES OF 20 π CASSIOPEIÆ—*Continued*

λ	7843		7848		7848		7854		7854		7857		7857	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572					−123·5	¼								
4549	+75·8	½	+100·4	¼	89·1	½	+69·3	¾	−65·6	¾				
4481			87·5	¾	83·0	¾	63·1	½	63·7	½	−94·9	¼	+ 85·3	¼
4415													87·2	½
4340	69·6	½									62·1	½	98·8	½
4325							66·5	¼	81·6	½				
4307	75·8	½									94·0	¼		
4294	80·8	½									69·0	½	84·6	½
4290							78·1	½	63·2	½	87·1	¼	82·3	¼
4271	76·7	¼			86·0	½			67·3	½	97·7	½		
4250	71·5	½												
4236	89·9	½											100·1	½
4233									69·7	½	66·1	¼		
4227			98·3	¼	90·2	½								
4202			89·0	¼			77·1	½						
4198					101·5	½								
4143			113·0	½	74·8	½								
4101													77·1	¼
4077											56·9	½	88·5	¼
4071					54·4	½	83·5	½						
4063					63·7	½	81·1	½	28·3	½				
4045	+ 84·8	½	114·8	¾			81·8	¼	52·3	½	−78·2	¾	+101·3	¼
4005			+ 93·1	¼	− 75·9	½	+77·0	½	−74·9	½				
Weighted mean	+ 78·21		+ 101·13		− 81·75		+ 75·01		− 63·03		− 76·48		+ 90·43	
V_a	+ 7·49		+ 7·15		+ 7·15		+ 6·74		+ 6·74		+ 6·38		+ 6·38	
V_d	+ ·03		+ ·18		+ ·18		+ ·06		+ ·06		+ ·14		+ ·14	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 85·4		+ 108·2		− 74·7		+ 81·5		− 56·5		− 70·2		+ 96·7	

MEASURES OF 20 π CASSIOPEIÆ—*Continued*

λ	7869		7869		7870		7870		7878		7879		7889	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584									− 1·2	½	+34·9	½		
4572									+ 5·8	¾	+11·2	½		
4549									+ 6·9	¾	+27·8	½	−69·8	½
4534					+54·4	½							52·0	¼
4481	+73·4	¼							+18·7	¾	+ 9·2	½	79·0	¼
4404											+18·0	½		
4351									+ 2·9	½	+38·7	½	56·9	¼
4340	68·7	½	−122·7	¼					+19·5	½	+ 3·0	¼	92·9	¼
4325									+16·5	¼			52·8	¼
4307					43·2	½	−67·5	¼	+ 5·5	¾				
4294													56·9	¼
4290	89·7	¼	67·3	¼	63·5	½	74·9	½	+ 2·0	½	+ 5·2	½		
4271	82·2	½	72·7	½					+ 5·5	½	+ 7·4	½	72·3	¼
4260	41·4	¼	74·7	½			56·1	¼					57·4	¼
4250	73·6	½			72·1	¼								
4236									−16·9	½				
4233			68·1	¼			61·2	¼	− 1·4	½	+13·0	½	98·0	¼
4227							84·9	¼	+10·6	½			73·7	¼
4215					65·1	½	52·3	¼			+ 6·7	¼		
4202									+20·4	½				
4198									+ 0·6	½			66·9	½
4143	78·7	½	− 57·9	¼	67·9	¼	57·6	¼	+ 8·8	½	+ 5·4	½		
4077													73·3	¼
4071					73·3	½								
4063					47·5	½	52·5	¼						
4045	+79·4	¼			48·4	½	53·8	½	+ 7·4	¾	− 7·2	½	71·6	½
4005					+46·7	¼	−82·6	¼			+ 5·5	½	−66·4	¼
Weighted mean	+ 74·13		− 76·30		+ 57·47		− 64·30		+ 6·60		+ 13·35		− 69·58	
V_a	+ 4·46		+ 4·46		+ 4·46		+ 4·46		+ 1·63		+ 1·63		− 5·23	
V_d	+ ·19		+ ·19		+ ·15		+ ·15		+ ·10		+ ·03		+ ·11	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 78·5		− 72·0		+ 61·8		− 60·0		+ 8·0		+ 14·7		− 75·0	

MEASURES OF 20 π CASSIOPEIÆ—*Continued*

λ	7889		7902		7902		7909		7909		7912		7912	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	+ 89·2	½	−143·4	½	+144·7	¾	+162·6	½	−106·4	½	+118·7	½	−55·8	¼
4481	96·3	¼	101·3	¾	129·3	¾	135·2	¼	142·5	¼	106·4	½	56·1	½
4404			87·9	½										
4395			114·7	½										
4351	94·6	¼					115·3	¼	96·1	¼	133·3	½	49·4	½
4340	89·4	¼	105·1	½	140·3	½	123·9	½	88·4	½	128·5	¼	75·1	¼
4325	109·0	½	113·0	½	132·0	¼								
4300							142·4	½	88·4	½	128·3	½	79·0	¼
4294	100·9	½												
4290							163·7	½	82·2	½				
4271							154·4	½	58·4	½			49·8	¼
4250									81·1	½				
4236					130·2	¼	133·3	½			137·7	¼		
4233									77·6	¼			90·3	½
4227	106·7	¼			119·8	½	141·8	½			140·0	½	43·0	½
4202							117·4	½			114·2	½		
4198									82·1	½				
4143							114·9	¼	78·5	½				
4101							151·4	½						
4077							133·2	½						
4063							140·6	½			97·6	½	−67·7	¼
4045	93·1	¼	− 94·5	½	+153·2	¼	+146·3	½	− 72·8	¼	+101·8	½		
4005	+ 72·3	¼												
Weighted mean	+ 94·40		− 108·05		+ 135·23		+ 140·24		− 85·96		+ 119·22		− 61·94	
V_a	− 5·23		− 11·35		− 11·35		− 11·82		− 11·82		− 11·82		− 11·82	
V_d	+ ·11		+ ·13		+ ·13		+ ·05		+ ·05		− ·18		− ·18	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 86·6		− 119·6		+ 123·8		+ 128·2		− 98·0		+ 106·9		− 74·2	

MEASURES OF 20 π CASSIOPEIÆ—*Continued*

λ	7916		7916		7920		7920		7976		7976		7977	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584	− 91·3	½	+155·3	¼									−60·1	½
4572					+148·9	½								
4549	80·0	½	130·4	¼					−67·6	½	+140·4	½	49·9	½
4534													61·0	½
4481	70·9	½	154·5	½			− 41·3	¼	42·1	½	157·0	½	58·5	½
4415											136·0	½		
4404	116·0	¼	116·2	¼					73·6	½			74·3	¼
4395									36·5	½			59·8	¼
4351					106·8	½			64·9	¼	166·9	¼		
4340	50·2	½	139·6	¼			43·1	½	48·7	¾			75·2	½
4325													50·4	½
4307	55·4	¼											44·8	½
4300	93·9	½	126·7	½	104·4	¼	70·8	¼					54·1	½
4294											138·6	¾		
4290	87·9	½	173·1	½										
4271	86·8	½	140·4	¼	145·0	½	−105·4	¼	68·0	¼	131·6	¼	31·1	½
4260									43·8	¼				
4250	94·3	½	141·4	¼									62·3	½
4236			127·8	½	137·5	¼								
4233	87·1	½											43·0	½
4227													84·5	¼
4198	104·1	½												
4101	71·8	¼	144·4	¼										
4077	117·5	¼	116·0	¼									41·2	½
4071			101·7	½	130·8	½								
4045	88·3	½	+124·9	½	+135·0	¼			−67·7	½	+158·5	¼	−83·2	½
4005	− 95·0	½												
Weighted mean	− 86·41		+ 134·98		+ 130·78		− 65·15		− 57·31		+ 144·93		− 56·65	
V_a	− 12·10		− 12·10		− 13·14		− 13·14		− 22·80		− 22·80		− 23·01	
V_d	+ ·03		+ ·03		+ ·05		+ ·05		− ·07		− ·07		− ·02	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 98·7		+ 122·6		+ 117·4		− 78·5		− 80·5		+ 121·8		− 80·0	

MEASURES OF 20 π CASSIOPEIÆ—*Continued*

λ	7977		7978		7978		7981		7981		7982		7982	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549			−59·4	¼			+147·6	¼	−106·9	¼	+194·8	¼	− 86·3	¼
4534	+149·9	½												
4481	139·4	½	87·7	¾	+159·1	¼			55·4	¼	161·0	¼	45·1	¼
4404	152·5	¼									168·3	¼		
4395			84·1	¼	143·0	¼								
4351									100·3	½	144·2	¼	86·6	½
4340	116·3	½	48·5	½	153·4	½	165·3	½	88·1	½	154·6	½	66·0	¼
4300					124·5	½					137·2	¼	90·0	¼
4294	121·6	½			145·6	¼							91·0	½
4290									127·8	½				
4271			72·3	¼	166·2	½			112·0	¼	125·9	¼		
4250			69·2	½	181·1	¼	143·4	¼			145·4	¼		
4236					158·0	¼	166·8	½						
4233			67·8	½										
4227	153·9	¼					160·2	½	78·1	½				
4202							139·4	¼			135·0	½		
4198	104·7	½	47·1	¼	162·8	½			49·6	¼			70·5	¼
4143							166·4	¼						
4101					146·7	½					163·7	¼	120·9	¼
4077			81·1	½					91·7	¼				
4071							157·7	½						
4063			62·5	¼	171·6	¼	156·4	½			160·1	1		
4045	+138·7	½	79·4	¼	159·6	½	172·0	½	84·9	¼	144·2	1	115·0	¼
4005			75·7	¼	152·3	¼			57·4	¼	180·0	¼		
3933			−62·8	½	+133·0	¼	+149·9	½	− 80·4	½	+176·0	½	− 115·0	¼
Weighted mean	+ 133·29		− 70·10		+ 155·48		+ 158·55		− 88·61		+ 155·15		− 88·67	
V_a	− 23·01		− 23·01		− 23·01		− 23·43		− 23·43		− 23·43		− 23·43	
V_d	− ·02		− ·09		− ·09		− ·11		− ·11		− ·16		− ·16	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+110·0		− 93·5		+ 132·1		+ 134·7		− 112·4		+ 131·3		− 112·5	

MEASURES OF 20 π CASSIOPEIÆ—*Continued*

λ	8004		8004		8007		8007		8038		8039		8060	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572	+156·8	½	− 55·6	¼					+ 49·9	¾			−60·9	½
4549	201·0	¼	106·8	¼	−66·8	¼	+177·0	¼	42·0	¾	+45·5	½	28·2	½
4534													66·3	¾
4481	189·4	½	78·8	¼	73·3	¾			53·3	¾	18·9	½		
4404			110·7	½										
4395											29·5	½		
4351									34·3	¾	30·4	¾		
4340					55·8	½	149·2	½	22·2	¼	28·1	½		
4325					93·2	¼	142·0	¼	43·9	¾	33·3	¼		
4307									27·9	½	28·5	¾	43·2	¼
4294													53·9	½
4290									34·5	½	22·2	½		
4271	162·4	½	85·8	¼	−53·0	½	138·5	¼	50·1	½	23·0	½	36·3	¾
4250			76·5	½					16·5	½	41·4	¼		
4236							+143·9	¼	40·4	½	26·8	½		
4233									39·1	½	50·6	½	55·7	½
4215									27·8	½	38·2	½	30·3	½
4202									41·8	½				
4198			72·2	¼					22·2	¼				
4143									31·8	1	37·6	½	21·2	¾
4077	142·5	¼												
4071	149·3	¼							31·5	½				
4063	160·2	½	99·0	¼							26·1	1		
4045	+164·4	1	− 82·8	¼					+ 40·2	1	+35·9	1	−52·4	¾
Weighted mean	+ 165·81		− 86·84		− 66·13		+ 149·93		+ 37·72		+ 31·63		− 44·23	
V_a	− 23·72		− 23·72		− 23·70		− 23·70		− 22·11		− 22·11		− 19·83	
V_d	− ·05		− ·05		− ·07		− ·07		− ·14		− ·18		− ·15	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 141·8		− 110·9		− 90·2		+ 125·9		+ 15·2		+ 9·1		− 64·5	

MEASURES OF 20 π CASSIOPEIÆ—*Continued*

λ	8069		8234		8234		8239		8239		8240		8240	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584	+104·4	¾												
4572	112·3	½												
4549	102·3	½					+84·5	½	−120·2	½				
4534	109·7	½												
4481			+ 79·7	½	−137·4	¼	95·3	½	108·5	¼	+ 81·6	¼	−111·5	¼
4415	115·1	½	82·9	¼			67·9	½						
4404											113·9	½		
4340							75·2	½	89·8	½	88·8	¼	−131·0	¼
4307	129·9	¼	76·2	¼	84·0	¼			77·5	½				
4290	88·7	½					61·7	½	70·9	½				
4271											92·0	¾		
4236	85·3	½					65·7	½			108·5	½		
4215	98·3	½												
4202			102·2	½										
4198											113·4	½		
4143	+ 95·1	¼	61·5	½			60·7	½			79·7	½		
4077							84·0	½						
4045			89·0	½	94·5	¼	+77·8	½	− 75·8	½	+ 98·9	¾		
4005			+104·5	¼	−101·0	¼								
Weighted mean	+ 103·17		+ 84·30		− 104·22		+ 74·71		− 88·76		+ 98·38		− 121·25	
V_a	− 19·83		+ 22·98		+ 22·98		+ 22·98		+ 22·98		+ 22·98		+ 22·98	
V_d	− ·15		+ ·10		+ ·10		+ ·15		+ ·15		+ ·09		+ ·09	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 82·9		+ 107·1		− 81·4		+ 97·6		− 65·9		+ 121·2		− 98·5	

MEASURES OF 20 π CASSIOPEIÆ—*Concluded*

λ	8265		8265		8267		8267		8268		8268		7931	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584													+30·5	1
4572													24·0	½
4549	−113·2	½	+139·1	½	+127·2	½			−147·7	¼			24·6	1
4534													39·5	1
4481	137·4	¼	124·4	¼	94·0	½	−132·9	½	138·2	½	+105·5	½	24·7	1
4404													41·4	½
4395													29·5	½
4351					85·3	¼	103·2	¼					45·2	¾
4340			80·6	¼	109·3	¾	103·6	¾	99·4	½	122·4	½	18·7	½
4325													32·3	1
4307													18·6	1
4300													52·1	1
4290													45·4	1
4271					112·9	¾	116·7	¼	117·3	½	90·2	½	26·9	1
4250					134·9	½	121·3	¼	124·2	½	134·0	½	8·9	1
4236					111·1	½					123·1	½	27·3	½
4233									129·8	½				
4202											114·6	½		
4198							−100·0	½					32·7	1
4143													26·4	1
4063					97·3	¼					121·0	½	13·7	½
4045	−129·4	¼	+140·8	¼	107·1	¼			−122·2	½	+116·8	½	29·2	1
4005					+110·7	½							+34·7	1
Weighted mean	− 123·20		+ 124·72		+ 110·30		− 111·84		− 123·84		+ 113·80		+ 30·28	
V_a	+ 21·88		+ 21·88		+ 21·76		+ 21·76		+ 21·63		+ 21·63		− 18·89	
V_d	+ ·15		+ ·15		+ ·18		+ ·18		+ ·12		+ ·12		− ·05	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 101·5		+ 146·5		+ 132·0		− 90·2		− 102·4		+ 135·3		+ 11·0	

A plot of the observations showed the period to be approximately 2 days. Using the four early observations in conjunction with our own, the period was found to be 1·96408 days. The plates were grouped according to phase into 20 normal places, the first 11 representing component I and the last 9 component II.

NORMAL PLACES

	Mean Phase	Mean Velocity	Weight	O–C Preliminary	O–C Final	Eq.-Eph.
1	·004	+ 94·9	·33	− 4·4	− 0·1	+ ·1
2	·063	+ 74·9	·73	− 5·9	− 2·5	+ ·1
3	·237	+ 12·4	·89	− 2·4	− 2·2	+ ·2
4	·463	− 70·9	·47	− 4·4	− 7·0	− ·1
5	·590	− 90·1	·89	+ 5·0	+ 2·4	·0
6	·815	− 98·5	·58	+ 3·4	+ 1·6	− ·1
7	·977	− 71·1	·81	+ 1·0	− 0·2	− ·1
8	1·231	+ 10·9	1·14	− 1·8	− 2·1	·0
9	1·495	+101·6	·31	− 1·3	+ 1·2	·0
10	1·627	+128·5	·35	− 0·9	+ 3·5	+ ·1
11	1·764	+130·0	·72	− 5·0	+ 0·5	+ ·1
12	·004	− 73·3	·26	+ 0·7	− 2·1	− ·1
13	·063	− 55·9	·66	− 0·6	− 2·5	− ·1
14	·463	+ 84·5	·36	− 9·2	− 5·4	·0
15	·599	+123·1	·68	− 0·9	+ 2·7	− ·1
16	·814	+129·7	·56	+ 0·3	+ 3·0	− ·1
17	·979	+ 98·5	·58	− 0·3	+ 1·9	− ·1
18	1·495	− 71·1	·18	+ 6·6	+ 5·6	·0
19	1·672	−110·7	·24	− 2·0	− 5·0	+ ·2
20	1·758	− 98·1	·55	+12·3	+ 8·4	− ·1

The preliminary values of the elements used were,

$$P = 1 \cdot 96408 \text{ days}$$
$$e = \cdot 02$$
$$\omega_1 = 45°$$
$$\omega_2 = 225°$$
$$\gamma = +13 \cdot 10 \text{ km.}$$
$$K_1 = 121 \text{ km.}$$
$$K_2 = 122 \cdot 42 \text{ km.}$$
$$T = \text{J. D. } 2{,}419{,}970 \cdot 035$$

Using these values and making the substitutions,

$$x = \delta\gamma$$
$$y_1 = \delta K_1$$
$$y_2 = \delta K_2$$
$$z = 100 \cdot \delta e$$
$$u = 100 \cdot \delta\omega$$
$$v = [2 \cdot 50528]\ \delta T$$

observation equations connecting the elements were built up in the usual way and a least-squares solution effected. It was later found necessary to consider T fixed, owing to the small value of e which made the coefficients of ω and T practically the same.

OBSERVATION EQUATIONS 20 π CASSIOPEIÆ

	Weight	x	y_1	y_2	z	u	$-n$
1	·33	1·000	+ ·712	....	+ ·846	− ·883	− 4·4=0
2	·73	1·000	+ ·559	....	+ ·430	−1·032	− 5·9=0
3	·89	1·000	+ ·014	....	− ·869	−1·227	− 2·4=0
4	·47	1·000	− ·658	....	− ·934	− ·914	− 4·4=0
5	·89	1·000	− ·894	....	− ·090	− ·523	+ 5·0=0
6	·58	1·000	− ·950	....	+1·171	+ ·306	+ 3·4=0
7	·81	1·000	− ·704	....	+ ·882	+ ·825	+ 1·0=0
8	1·14	1·000	− ·003	....	− ·816	+1·193	− 1·8=0
9	·31	1·000	+ ·742	....	− ·805	+ ·813	− 1·3=0
10	·35	1·000	+ ·964	....	+ ·152	+ ·373	− 0·9=0
11	·72	1·000	+1·007	....	+1·036	− ·162	− 5·0=0
12	·26	1·000	....	− ·712	− ·856	+ ·894	+ 0·7=0
13	·66	1·000	....	− ·559	− ·435	+1·044	− 0·6=0
14	·36	1·000	....	+ ·658	+ ·945	+ ·924	− 9·2=0
15	·68	1·000	....	+ ·906	+ ·018	+ ·496	− 0·9=0
16	·56	1·000	....	+ ·950	−1·184	− ·308	+ 0·3=0
17	·58	1·000	....	+ ·700	− ·883	− ·840	− 0·3=0
18	·18	1·000	....	− ·742	+ ·814	− ·823	+ 6·6=0
19	·24	1·000	....	− ·998	− ·499	− ·203	− 2·0=0
20	·55	1·000	....	−1·009	−1·023	+ ·141	+12·3=0

NORMAL EQUATIONS

$$11{\cdot}290x - {\cdot}288y_1 + {\cdot}307y_2 - 1{\cdot}556z + {\cdot}258u + 5{\cdot}752 = 0$$
$$3{\cdot}453y_1 \ldots\ldots + {\cdot}190z - {\cdot}394u + 12{\cdot}743 = 0$$
$$2{\cdot}738y_2 + {\cdot}145z - {\cdot}451u + 9{\cdot}835 = 0$$
$$7{\cdot}253z + {\cdot}490u + 7{\cdot}331 = 0$$
$$7{\cdot}505u - 3{\cdot}387 = 0$$

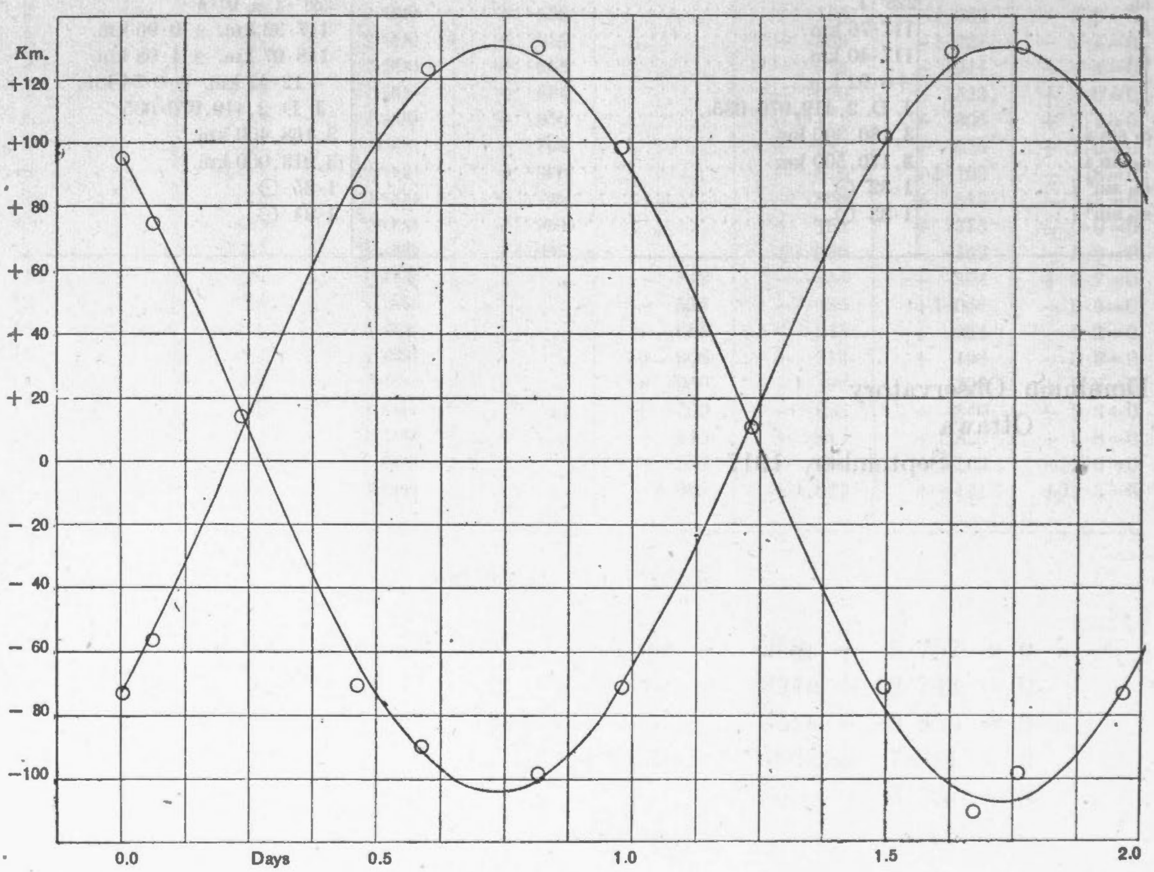
From these equations resulted the corrections,

$$\delta\gamma = -0{\cdot}68 \text{ km.}$$
$$\delta K_1 = -3{\cdot}68 \text{ km.}$$
$$\delta K_2 = -3{\cdot}45 \text{ km.}$$
$$\delta e = -0{\cdot}010$$
$$\delta\omega = +0^\circ{\cdot}08$$

The value of Σpvv for the normal places was reduced from 218·3 to 116·7. The accompanying graph represents the final elements and the observations as grouped. The probable error for a plate for component II is ±5·0 km. per sec., and for component I is ±4·7 km. per sec. The table below gives the elements from the unrevised and revised wave-lengths. The latter values supersede the others and are considered final. The probable errors are attached.

Element	Values from Unrevised Wave-Lengths	Final Values
P	1·96408 days	1·96408 days
e	·009	·010 ± ·007
ω_1	45°·1	45°·1 ± 0°·4
ω_2	225°·1	225°·1 ± 0°·4
K_1	117·76 km	117·32 km. ± 0·96 km.
K_2	117·40 km	118·97 km. ± 1·08 km.
γ	+8·92 km	+12·42 km. ± 0·54 km.
T	J. D. 2,419,970·035	J. D. 2,419,970·035
$a_1 \sin i$	3,180,300 km	3,168,400 km.
$a_2 \sin i$	3,170,500 km	3,213,000 km.
$m_1 \sin^3 i$	1·32 ⊙	1·35 ⊙
$m_2 \sin^3 i$	1·33 ⊙	1·34 ⊙

Dominion Observatory
Ottawa
September, 1917



Radial Velocity Curves of 20 π Cassiopeiæ

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 10

ORBIT OF THE SPECTROSCOPIC BINARY 32 θ^2 CYGNI

BY J. B. CANNON, M.A.

32 θ^2 Cygni ($\alpha=20^h\ 12^m$, $\delta=+47°\ 24'$, mag. 5.15, type G5) was announced a binary in *L. O. B.* 4, p. 96, from four measures giving a range of 30 km. Later in *A. N.* 4750, Küstner published three measures of plates taken in 1908, 1909 and 1911, having a range of 40 km. The star was under observation here during the years 1914, 1915, 1916 and 1917, during which time 117 plates were taken.

The following determination of the elements must be considered as preliminary. The period being so long—1170 days— the measures were only beginning to repeat themselves at the end of the fourth year. More observations several years hence may change the period by some days but the other elements, as determined, are probably fairly accurate. Five plates taken in 1908 helped in the determination of the period.

The wave-lengths of the lines used are given in Table I. Table IV contains the observations,—number of the plate, date, phase, velocity, and residual.

TABLE I

4571·896	4395·461	4289·872
4549·646	4351·674	4282·858
4523·052	4340·705	4271·888
4501·865	4326·076	4215·906
4415·200	4304·891	4128·108
4404·042	4294·514	4101·653

TABLE II

LICK OBSERVATIONS OF 32 θ^2 CYGNI

Date	Julian Day	Velocity	Phase	Residual
1905, June 7	2,417,004	−25	983·61	+4·0
Aug. 13	071	−24	1050·61	−4·6
1906, July 22	414	+ 2	223·61	−2·2
Aug. 1	424	+ 5	233·61	+0·3

TABLE III

KÜSTNER'S OBSERVATIONS OF 32 θ^2 CYGNI

Date	Julian Day	Velocity	Phase	Residual
1908, Oct. 30·25	2,418,245·25	−18·4	1054·39	+ 0·6
1909, Oct. 2·33	582·33	+14·6	221·94	+10·4
1911, Aug. 31·39	2,419,280·39	−26·3	920·00	+ 9·3

TABLE IV

OTTAWA OBSERVATIONS OF 32 θ^2 CYGNI

Plate	Julian Day	Velocity	Phase	Residual
3714	2,418,952·600	−11·4	592·2	+ 6·1
3733	957·605	−12·6	597·2	+ 5·2
3745	962·586	−11·6	602·2	+ 5·8
3762	964·670	−14·7	604·3	+ 2·6
3767	965·590	−13·8	605·2	+ 3·4
6111	2,420,300·826	−34·0	770·4	− 9·0
6122	303·774	−22·7	773·4	+ 2·3
6128	306·817	−20·9	776·4	+ 4·6
6137	310·834	−29·3	780·4	− 3·1
6138	314·733	−28·4	784·3	− 1·4
6146	317·789	−31·4	787·4	− 4·4
6163	322·733	−23·9	792·3	+ 4·3
6168	323·649	−32·5	793·2	− 4·6
6176	327·790	−39·1	797·4	−11·1
6188	329·855	−41·6	799·5	−12·6
6197	331·753	−38·1	801·4	− 8·9
6215	335·722	−34·5	805·3	− 5·0
6222	338·731	−40·0	808·3	−10·0
6227	341·738	−25·2	811·3	+ 5·0
6243	348·674	−24·2	818·3	+ 6·0
6265	350·670	−22·4	820·3	+ 8·6
6275	359·727	−40·1	829·3	− 8·1
6300	369·633	−41·9	839·2	− 8·4
6306	370·593	−34·1	840·2	+ 0·8
6355	387·660	−41·5	857·3	− 6·5
6362	388·667	−34·5	858·3	+ 0·5
6368	390·596	−34·6	860·2	+ 0·6
6384	392·632	−29·5	862·2	+ 4·7
6415	397·632	−35·5	867·2	± 0·0
6425	401·592	−26·8	871·2	+ 8·9
6438	404·581	−34·6	874·2	+ 1·1
6453	407·551	−25·4	877·2	+10·5
6503	420·562	−34·3	890·2	+ 1·9
6511	427·539	−32·3	897·2	+ 4·1

TABLE IV

OTTAWA OBSERVATIONS OF 32 θ^2 CYGNI—*Continued*

Plate	Julian Day	Velocity	Phase	Residual
6541	2,420,439·571	−34·0	909·2	+ 2·0
6568	460·529	−35·7	930·1	− 0·7
6579	464·535	−28·8	934·1	+ 0·9
6612	478·479	−38·4	948·1	− 4·9
6714	511·448	−34·3	981·0	− 4·8
6833	560·901	−30·9	1030·5	− 8·1
6929	602·856	−17·7	1072·5	− 0·9
6952	609·892	+ 0·5	1079·5	+16·5
6963	621·862	−20·6	1091·5	− 5·8
6972	624·835	−22·4	1094·4	− 7·9
6983	628·859	−10·8	1098·5	+ 3·2
7006	637·850	−10·2	1107·4	+ 3·3
7015	644·839	−11·5	1114·4	+ 1·3
7061	665·802	−12·1	1135·4	− 0·6
7084	680·690	− 1·8	1150·3	+ 8·9
7090	687·760	− 7·8	1157·4	+ 2·7
7102	693·760	−18·4	1163·4	− 8·2
7110	698·844	−12·1	1168·4	− 2·1
7129	707·763	−13·2	7·4	− 3·4
7149	720·737	− 5·4	20·3	+ 3·6
7165	733·765	− 3·6	33·4	+ 5·0
7187	742·632	− 8·1	42·4	+ 0·2
7216	749·705	+ 4·3	49·3	+12·5
7221	750·617	−11·2	50·2	− 3·1
7259	758·627	− 1·2	58·2	+ 6·6
7299	770·493	− 7·0	70·1	+ 0·5
7322	779·514	− 7·1	79·1	+ 0·2
7342	786·597	− 5·8	86·2	+ 1·2
7360	794·494	− 2·0	94·1	+ 4·5
7371	801·471	− 5·1	101·1	+ 1·2
7376	807·602	− 2·0	107·2	+ 3·8
7395	814·495	−10·5	114·1	− 5·2
7424	824·476	− 4·1	124·1	+ 0·4
7434	833·464	−10·1	133·1	− 6·1
7448	843·470	−10·0	143·1	− 7·0
7451	852·453	− 6·4	152·1	− 4·1
7455	860·437	+ 5·0	160·0	+ 6·3
7474	870·462	− 1·0	170·1	− 0·5
7488	880·474	− 4·6	180·1	− 5·1
7492	891·466	− 3·0	191·1	− 4·5
7555	940·913	+ 1·7	240·5	− 3·3
7620	973·865	− 4·0	273·4	−10·6
7630	986·774	+ 5·1	286·4	− 1·3
7663	2,421,003·688	+ 3·9	303·3	− 1·8
7679	015·692	+ 7·0	315·3	+ 2·0
7696	028·751	+ 9·1	328·4	+ 4·9
7701	036·755	+ 0·9	336·3	− 2·6
7712	044·837	− 0·4	344·4	− 2·9
7719	050·835	− 2·0	350·4	− 4·0
7730	058·686	− 5·3	358·3	− 6·3

TABLE IV

OTTAWA OBSERVATIONS OF 32 θ^2 CYGNI—*Concluded*

Plate	Julian Day	Velocity	Phase	Residual
7746	2,421,064·801	− 6·6	364·4	− 6·6
7763	076·778	+ 2·3	376·4	+ 3·8
7781	090·763	−10·5	390·3	− 7·0
7800	106·583	− 4·6	406·2	+ 1·1
7812	122·571	− 0·2	422·2	+ 8·3
7821	133·531	− 9·0	433·1	+ 1·0
7835	139·532	−11·1	439·1	− 0·6
7864	146·530	− 7·5	446·1	+ 4·0
7897	179·449	−11·8	479·0	+ 3·4
7903	188·510	−15·6	488·1	+ 0·6
7929	212·434	− 5·4	512·0	+12·6
8129	314·855	− 7·1	614·4	+ 9·1
8157	342·868	−17·7	642·5	− 1·9
8168	362·843	−17·3	662·4	− 1·5
8189	379·829	−21·9	679·4	− 5·4
8196	394·836	−19·4	694·4	− 2·1
8204	398·833	−16·8	698·8	+ 0·7
8212	407·827	−18·7	707·4	− 0·7
8215	414·831	−18·7	714·4	− 0·4
8224	425·709	−15·3	725·3	+ 4·0
8230	429·772	−11·7	729·4	+ 7·8
8242	435·777	−16·5	735·4	+ 3·8
8248	440·774	−20·2	740·4	+ 0·5
8261	447·774	−22·0	747·4	− 0·7
8270	460·660	−19·2	760·3	+ 4·0
8271	461·799	−32·8	761·4	− 9·3
8277	471·732	−22·8	771·3	+ 2·2
8284	478·677	−23·4	778·3	+ 2·8
8299	485·604	−21·4	785·2	+ 5·6
8302	495·611	−24·3	795·2	+ 3·7
8327	518·566	−43·3	818·2	−12·3
8353	546·534	−45·2	846·1	−11·2
8402	593·434	−37·1	893·0	− 5·7

MEASURES OF 32 θ² CYGNI

λ	3714 Vel.	3714 Wt.	3733 Vel.	3733 Wt.	3745 Vel.	3745 Wt.	3762 Vel.	3762 Wt.	3767 Vel.	3767 Wt.	6111 Vel.	6111 Wt.	6122 Vel.	6122 Wt.
4571·896	− 5·70	½	− 1·36	½	+ 4·57	¼	− 2·71	¼	+ 5·94	½	−37·37	½	−28·88	½
4549·646	− 1·72	½					+ 0·68	¼	− 6·17	¼	−56·30	¼	−30·56	¼
4523·052											−37·15	¼	−35·99	¼
4501·865											−40·77	½	−32·68	¼
4415·200	+ 6·51	½	+ 0·42	¼	− 7·85	¼					−50·60	¼	−33·10	¼
4404·042	− 2·80	¼	− 2·44	¼	− 3·51	¼					−48·90	¼	−39·64	¼
4395·461											−48·96	½		
4351·674	−15·25	¼	− 3·43	¼			− 7·75	¼	− 9·40	¼	−54·70	¼	−33·15	½
4340·705	− 5·12	½	− 5·00	½					+ 3·48	¼	−45·20	1	−35·43	¼
4314·891	+ 4·50	½	− 0·14	½	+ 2·21	¼			− 7·78	½	−33·32	½	−27·47	½
4294·514													−40·44	¼
4289·872											−29·49	¼	−32·22	¼
4271·888											−39·36	¼		
4215·906											−44·06	1		
4128·108											−41·18	½		
Weighted mean	− 1·76		− 2·05		− 0·47		− 3·26		− 2·25		− 44·94		− 32·83	
V_a	− 9·34		− 10·12		− 10·76		− 11·02		− 11·15		+ 11·29		+ 11·09	
V_d	− 0·07		− 0·12		− 0·12		− 0·19		− 0·13		− 0·01		+ 0·04	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 11·4		− 12·6		− 11·6		− 14·7		− 13·8		− 34·0		− 22·7	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	6128		6137		6138		6146		6163		6168		6176	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	−33·26	½	−45·59	½	−31·80	½	−37·90	¼	−33·65	½	−46·51	½	−44·92	¼
4549·646	−38·92	¼	−29·25	¼	−36·31	¼	−43·49	¼	−43·09	¼	−42·71	¼	−52·64	¼
4523·052	−46·00	¼	−39·84	¼	−29·83	¼	−46·64	¼	−40·87	½	−35·99	¼	−43·43	½
4501·865	−30·53	½	−37·86	¼	−42·28	¼	−37·86	½	−36·60	¼	−58·34	¼	−40·77	¼
4415·200	−35·84	¼	−38·58	¼	−44·65	¼	...	...	−22·51	¼	−29·06	½	−58·81	¼
4395·461	...	...	−36·73	½	−36·85	½	−52·55	¼	−38·72	¼	−46·46	¼	−41·71	¼
4340·705	−26·68	½	−43·28	½	−32·70	1	−26·62	¼	−12·77	½	−63·21	¼	...	...
4326·076	−30·78	½	...	...	−36·00	¼	...	...	...	...	...	...	...	...
4314·891	−21·29	½	−36·86	½	−42·60	½	...	...	−35·75	½	−25·26	½	...	...
4294·514	...	...	−41·52	½	−53·59	½	...	...	−32·06	¼	...	...	...	...
4289·872	−22·23	¼	...	...	−39·02	¼	...	...	...	...	...	...	...	...
4282·858	...	...	−36·21	¼	...	...	...	...	...	...	...	...	...	...
4215·906	−41·30	¼	−38·03	¼	−33·64	½	...	...	−32·13	¼	...	...	...	...
Weighted mean	− 31·30		− 39·23		− 37·79		− 40·42		− 32·33		− 40·76		− 46·59	
V_a	+ 10·76		+ 10·27		+ 9·75		+ 9·37		+ 8·57		+ 8·42		+ 7·74	
V_d	− 0·03		− 0·06		± 0·00		− 0·04		+ 0·05		+ 0·12		− 0·07	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 20·9		− 29·3		− 28·4		− 31·4		− 23·9		− 32·5		− 39·1	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	6188		6197		6215		6222		6227		6243		6265	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	−50·76	½	−50·49	¼	−40·55	½	−43·66	½	−37·37	½	−25·55	½	−29·15	½
4549·646	−48·20	¼	−48·51	¼	−39·84	¼	−54·86	¼	−24·15	½	−44·28	¼	−18·80	¼
4523·052	−49·85	½	−56·39	½	−36·89	½	−37·27	½	−33·66	½	−30·86	¼	....	....
4501·865	−47·59	½	−40·39	½	−48·68	¼	−48·60	¼	−22·69	¼	−40·64	½	−17·52	¼
4415·200	....	....	....	....	....	....	....	....	....	....	−32·62	¼	−22·88	¼
4404·042	....	....	....	....	....	....	....	....	....	....	−26·30	¼	....	....
4395·461	−48·95	½	−27·95	¼	−37·67	½	....	....	−20·09	¼	....	....	....	....
4351·674	....	....	....	....	....	....	−43·00	¼	....	....	−46·40	¼	−23·20	¼
4340·705	−41·03	¼	−51·39	¼	−53·08	¼	−40·69	½	−35·85	¼	−17·27	¼	−24·92	½
4314·891	−49·44	½	−38·51	½	−39·40	1	−51·10	1	−32·44	½	−18·50	½	−21·40	½
4294·514	....	....	....	....	....	....	−42·07	½	−28·26	½	−28·80	½	−23·37	¼
4289·872	....	....	....	....	−38·37	¼	....	....	....	....	−34·24	¼	−40·62	¼
4128·108	....	....	....	....	....	....	−48·30	¼	....	....	−20·88	¼	−31·90	¼
Weighted mean	− 48·54		− 44·90		− 40·55		− 45·41		− 30·02		− 28·53		− 25·48	
V_a	+ 7·39		+ 7·05		+ 6·32		+ 5·75		+ 5·17		+ 4·77		+ 3·36	
V_d	− 0·18		− 0·02		± 0·00		− 0·03		− 0·05		− 0·11		+ 0·02	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 41·6		− 38·1		− 34·5		− 40·0		− 25·2		− 24·2		− 22·4	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	6275		6300		6306		6355		6362		6368		6384	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	−38·43	¼	−40·81	½	−29·54	½	−33·52	½	−26·36	½	−15·35	¼	−17·61	½
4549·646	−38·74	¼	−37·67	¼	−27·68	½	−34·61	¼	−14·48	¼	−26·90	½	− 3·11	¼
4523·052	......	......	−32·40	¼	......	......	−27·01	½	......	......	......	......	......	......
4501·865	−44·05	¼	−46·58	¼	−31·29	½	−27·37	½	−24·46	½	−31·29	½	−23·58	¼
4415·200	−50·60	½	......	......	......	......	−34·17	¼	......	......	−16·80	¼	−15·97	¼
4404·042	......	......	......	......	−24·06	¼	......	......	−31·38	½	......	......	......	......
4395·461	−40·01	¼	−23·25	¼	−14·34	¼	......	......	−28·53	¼	−38·25	¼	−19·27	¼
4351·674	−56·11	¼	−44·08	½	−30·80	¼	−46·07	½	−28·80	¼	......	......	......	......
4340·705	−35·29	½	−44·63	½	−39·57	1	−45·42	½	−36·75	1	−43·62	½	−28·31	½
4326·076	......	......	......	......	......	......	−24·86	¼	−31·98	¼	......	......	−15·96	¼
4314·891	−41·27	¼	−41·60	½	−36·30	1	−41·16	½	−33·21	½	−29·68	1	−22·84	½
4294·514	−36·63	½	......	......	......	......	−38·37	¼	−27·94	¼	−25·98	¼	−17·07	¼
4289·872	......	......	......	......	−36·64	½	......	......	−31·87	½	−30·46	½	−28·62	½
4271·888	......	......	−50·22	¼	......	......	......	......	......	......	−28·65	½	......	......
4215·906	......	......	......	......	−34·56	½	−39·46	¼	−27·92	½	−26·70	½	−31·91	¼
4101·653	......	......	......	......	......	......	......	......	−15·91	¼	−20·08	¼	......	......
Weighted mean	− 41·18		− 40·94		− 32·95		− 36·59		− 29·32		− 29·18		− 23·58	
V_a	+ 1·44		− 0·70		− 0·91		− 4·51		− 4·76		− 5·15		− 5·56	
V_d	− 0·10		± 0·00		+ 0·04		− 0·11		− 0·12		− 0·03		− 0·06	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 40·1		− 41·9		− 34·1		− 41·5		− 34·5		− 34·6		− 29·5	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	6415		6425		6438		6453		6503		6511		6541	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	−26·10	½	−15·49	¼	−16·55	½	−11·64	½	−25·83	¼	−19·20	½	−32·19	½
4549·646	−22·19	¼	− 7·68	¼	−22·58	¼	−17·22	¼	−21·02	¼	−29·64	¼	...	...
4501·865	−25·35	¼	−12·20	¼	−39·50	½	− 8·00	½	−28·38	½	−23·07	½	−21·05	¼
4415·200	−26·08	¼	−17·99	¼	−20·61	¼	−17·74	¼	−21·08	½	−16·92	½	...	...
4404·042	...	...	−22·41	½	−36·23	¼	...	...	−20·75	¼	−15·91	½	−15·79	¼
4395·461	−26·53	¼	...	...	−27·35	¼	...	...	−29·11	½	−11·53	¼	...	...
4351·674	...	...	...	...	−40·50	¼	...	...	−29·60	¼	−33·12	¼	...	...
4340·705	−33·26	1	−22·00	1	−27·18	1	−20·31	½	−14·01	1	−15·13	1	−19·86	½
4326·076	...	...	−21·63	¼	...	...	...	...	...	...	−34·10	¼	−23·63	¼
4314·891	−30·01	½	−22·50	½	−29·46	½	−23·28	¼	−30·45	½	−28·91	½	−21·62	½
4294·514	−25·98	½	...	...	−21·63	½	−15·22	½	−15·76	¼	...	...	−26·09	¼
4289·872	−35·23	¼	...	...	−21·58	½	−24·51	¼	−24·40	½	−19·85	½	− 9·56	½
4271·888	...	...	−20·85	½	...	...	...	...	...	...	...	...	...	...
4215·906	−20·78	¼	−19·04	½	−13·12	¼	−17·10	½	...	...	−16·49	¼	...	...
4101·653	−32·70	¼	−12·85	¼	−27·69	¼	−24·17	¼	−34·10	¼	...	...	...	...
Weighted mean	− 28·59		− 19·19		− 26·39		− 16·76		− 23·50		− 20·62		− 21·16	
V_a	− 6·54		− 7·29		− 7·83		− 8·35		− 10·36		− 11·25		− 12·38	
V_d	− 0·11		− 0·08		− 0·08		− 0·03		− 0·11		− 0·11		− 0·16	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 35·5		− 26·8		− 34·6		− 25·4		− 34·3		− 32·3		− 34·0	

MEASURES OF 32 o^2 CYGNI—*Continued*

λ	6568		6579		6612		6714		6833		6929		6952	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	−26·89	½	−21·89	¼	−22·96	½	−28·02	¼	−28·20	¼	−23·16	½	− 6·88	¼
4549·646	−25·46	½	...	...	−32·15	¼	−17·85	¼	−53·20	¼	−27·41	¼	− 8·34	¼
4523·052	−20·76	¼	...	...	−16·77	¼	...	...	−35·20	¼	...	...	...	...
4501·865	−19·62	½	− 6·16	¼	−28·63	½	−31·94	¼	−28·02	¼	−34·19	½	...	...
4415·200	− 3·28	¼	−20·96	¼	−14·27	½	−28·13	½	...	...	−25·70	½	+10·21	¼
4404·042	−23·89	¼	−22·23	¼	−21·64	½	...	...	...	...	−34·17	½	−13·78	½
4395·461	−21·42	¼	+ 4·17	¼	−37·33	½	−30·97	½	...	...	...	...	− 9·54	¼
4351·674	...	...	−17·44	½	−29·49	¼	−15·74	¼	...	...	−21·60	½	+11·53	½
4340·705	−24·79	½	...	...	−21·96	½	...	...	−31·92	½	−32·46	½	− 8·94	¼
4326·076	...	...	...	...	...	...	...	...	−27·74	¼	−37·65	½	−26·74	¼
4314·891	−23·81	½	−20·14	½	−34·56	½	−36·34	½	−24·21	¼	−23·38	½	−23·90	½
4294·514	...	...	...	...	...	...	...	...	−35·42	¼	...	...	...	...
4289·872	−22·56	¼	...	...	−24·09	½	−28·23	¼	−35·51	¼	−26·30	½	−17·80	¼
4271·888	...	...	...	...	...	...	...	...	...	...	−19·24	¼	−19·45	½
4215·906	...	...	−11·25	¼	−25·21	½	−13·10	½	−41·83	½	−28·14	½	− 9·34	½
4128·108	...	...	...	...	...	...	...	...	...	...	−26·12	¼	...	...
4101·653	...	...	...	...	...	...	...	...	−33·69	¼	...	...	+ 9·91	¼
Weighted mean	− 22·17		− 15·35		− 25·70		− 26·06		− 33·78		− 28·10		− 10·62	
V_a	− 13·07		− 13·00		− 12·18		− 7·68		+ 2·98		+ 10·50		+ 11·30	
V_d	− 0·19		− 0·21		− 0·19		− 0·23		+ 0·19		+ 0·15		+ 0·10	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 35·7		− 28·8		− 38·4		− 34·3		− 30·9		− 17·7		+ 0·5	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	6963		6972		6983		7006		7015		7061		7084	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	−32·78	¼	−34·15	½	−21·50	½	−18·27	½	−22·62	¼	−28·20	½	− 6·20	½
4549·646	−30·60	¼	−36·82	¼	−11·87	¼	−10·81	¼	....	....	....	....	− 4·63	½
4523·052	−17·64	¼	−24·05	¼	−14·95	¼	....	....	−23·29	¼	−17·52	¼	−13·03	½
4501·865	−31·41	½	−47·72	½	−15·74	½	....	....	− 5·28	¼	− 9·43	¼	−18·02	¼
4415·200	−37·38	½	−30·96	¼	−25·28	¼	−24·50	½	−19·72	¼	−23·92	¼	− 0·97	½
4404·042	−43·62	¼	−45·65	½	−23·73	½	−30·54	½	−22·29	½	−17·93	½	−17·22	½
4351·674	−33·93	¼	−37·30	¼	−25·40	¼	....	....	− 5·83	¼	−23·90	¼	−23·21	¼
4340·705	−31·62	½	−30·31	½	−24·01	½	−24·91	½	−32·58	½	−23·11	½	− 2·97	½
4326·076	−49·25	¼	....	....	....	....	−17·74	¼	−41·01	¼	....	....	....	....
4314·891	−24·72	½	−18·84	½	−27·02	½	−16·40	½	−24·90	½	−26·10	½	−10·25	½
4294·514	....	....	....	....	−34·14	¼	....	....	....	....	....	....	....	....
4289·872	−34·91	¼	....	....	−33·30	¼	−27·20	¼	....	....	....	....	−23·00	½
4271·888	−34·21	¼	....	....	....	....	....	....	....	....	....	....	....	....
4215·906	−30·58	½	....	....	−24·66	½	−38·02	½	−23·12	½	−38·88	¼	−14·34	½
4101·653	....	....	....	....	....	....	....	....	−36·00	¼	....	....	....	....
Weighted mean	− 32·64		− 34·46		− 23·23		− 22·73		− 23·97		− 23·41		− 11·32	
V_a	+ 12·26		+ 12·43		+ 12·60		+ 12·76		+ 12·68		+ 11·51		+ 9·66	
V_d	+ 0·10		+ 0·11		+ 0·12		+ 0·05		+ 0·05		+ 0·03		+ 0·10	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 20·6		− 22·4		− 10·8		− 10·2		− 11·5		− 12·1		− 1·8	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	7090		7102		7110		7129		7149		7165		7187	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	+ 2·54	½	−16·96	½	−33·95	½	−31·10	½	− 6·47	½	− 0·63	½	−16·01	½
4549·646	−12·39	½	−19·82	¼	+ 3·42	½	−26·48	½	....	....	− 7·43	¼	−14·72	¼
4523·052	−19·95	½	−23·29	¼	....	....	−15·97	½	− 8·79	½	− 0·85	½	+22·24	¼
4501·865	−17·13	½	−27·75	½	−18·02	¼	−11·33	½	−10·31	¼	+ 2·58	½	+ 1·81	¼
4415·200	−16·68	¼	−25·11	¼	− 7·64	½	− 9·66	¼	+ 6·05	¼	+ 0·46	¼	+ 9·14	¼
4404·042	−24·17	¼	−32·69	½	−17·32	¼	−12·96	¼	−18·26	½	....	....	−19·46	¼
4351·674	−21·92	½	−32·58	¼	....	....	−39·22	¼	....	....	....	....	−30·96	¼
4340·705	−27·73	½	−26·96	½	−18·16	½	+ 0·62	½	+ 4·34	½	....	....	....	....
4314·891	− 9·12	½	−20·82	½	−27·33	½	−26·65	½	+ 0·70	½	−11·21	½	+ 4·01	¼
4294·514	−15·11	½	....	....	−26·81	½	−20·54	½	−14·13	½	....	....	− 2·40	½
4289·872	−19·20	¼	−28·30	½	−18·98	¼	....	....	....	....	....	....	....	....
4215·906	−17·91	½	−27·82	½	−18·63	½	....	....	−14·04	½	....	....	− 5·88	¼
Weighted mean	− 16·07		− 25·74		− 18·38		− 17·92		− 7·35		− 2·72		− 5·42	
V_a	+ 8·60		+ 7·61		+ 6·67		+ 5·09		+ 2·37		− 0·46		− 2·38	
V_d	− 0·01		− 0·03		− 0·13		− 0·10		− 0·11		− 0·14		− 0·03	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 7·8		− 18·4		− 12·1		− 13·2		− 5·4		− 3·6		− 8·1	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	7216 Vel.	7216 Wt.	7221 Vel.	7221 Wt.	7259 Vel.	7259 Wt.	7299 Vel.	7299 Wt.	7322 Vel.	7322 Wt.	7342 Vel.	7342 Wt.	7360 Vel.	7360 Wt.
4571·896	+28·66	½	−16·90	½	+11·38	½	− 3·02	½	+ 3·61	½	+ 2·15	½	+ 3·54	½
4549·646	......	......	− 5·72	¼	+ 5·26	¼	+ 3·29	¼	+13·22	¼	+ 9·57	½	......	......
4523·052	......	......	− 6·88	½	+ 8·13	½	+ 5·70	¼	+ 5·58	½	+ 8·26	½	+11·19	½
4501·865	+14·94	¼	+ 4·48	¼	+19·06	¼	− 6·79	½	−15·12	½	+ 7·00	½	+ 5·52	¼
4415·200	+12·13	½	− 1·21	¼	+ 4·03	½	+ 6·29	¼	+ 5·45	½	+14·26	¼	+18·10	½
4404·042	......	......	......	......	+ 7·47	¼	+ 0·14	¼	− 0·56	¼	......	......	− 6·11	¼
4351·674	......	......	......	......	− 4·48	¼	+ 2·76	¼	+ 4·38	¼	......	......	+10·68	¼
4340·705	+ 2·64	½	−18·50	¼	− 6·35	¼	+ 6·26	½	−10·86	¼	......	......	+14·22	½
4314·891	+ 1·01	½	+ 5·66	½	+ 3·11	½	+11·06	½	− 1·88	¼	+ 2·66	¼	+ 5·82	½
4294·514	......	......	− 4·78	½	+ 2·29	½	+ 9·02	½	+18·22	¼	......	......	+ 9·12	½
4289·872	......	......	......	......	......	......	− 2·32	½	+10·93	¼	......	......	+ 7·68	½
4215·906	+12·22	½	− 9·55	¼	− 0·97	¼	+ 3·42	½	− 3·11	¼	......	......	+18·18	½
Weighted mean	+ 8·55		− 6·79		+ 4·90		+ 2·83		+ 2·66		+ 7·09		+ 9·78	
V_a	− 3·88		− 4·08		− 5·73		− 9·62		− 9·45		− 12·47		− 11·44	
V_d	− 0·11		− 0·02		− 0·09		+ 0·05		− 0·01		− 0·12		− 0·05	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 4·3		− 11·2		− 1·2		− 7·0		− 7·1		− 5·8		− 2·0	

MEASURES OF 32 θ² CYGNI—*Continued*

λ	7371 Vel.	7371 Wt.	7376 Vel.	7376 Wt.	7395 Vel.	7395 Wt.	7424 Vel.	7424 Wt.	7434 Vel.	7434 Wt.	7448 Vel.	7448 Wt.	7451 Vel.	7451 Wt.
4571·896	+13·55	½	+ 7·68	1	+ 1·10	½	+ 6·46	¼	+ 6·48	½	+ 6·88	½	+ 4·36	½
4549·646	− 1·93	½	+21·64	¼	− 7·28	¼	+26·24	¼	− 7·08	¼	....	....	....	....
4523·052	+ 5·95	¼	+ 4·73	½	+ 7·50	½	+ 6·80	¼	+14·91	¼	+16·58	¼	+19·80	¼
4501·865	+ 6·98	¼	+21·52	¼	+ 8·62	½	+15·02	¼	+ 3·10	½	+ 6·15	¼	+ 7·55	½
4415·200	+11·52	¼	− 8·89	¼	+ 9·14	½	+ 7·96	½	....	....	....	....	+ 6·52	¼
4404·042	....	....	....	....	....	....	− 0·27	¼	....	....	....	....	+ 1·01	¼
4351·674	+ 3·82	¼	− 1·18	¼	....	....	+ 2·11	¼	− 7·00	¼	− 2·78	¼	− 7·22	¼
4340·705	+ 8·51	½	+35·92	½	−12·54	½	+13·98	½	+ 7·66	½	− 7·49	¼	+12·53	½
4314·891	+ 4·76	½	− 1·88	¼	+ 3·88	½	+ 5·37	½	+ 0·72	½	−12·88	¼	+ 2·04	½
4294·514	+ 5·76	½	....	....	+10·41	¼	....	....	....	....	....	....	....	....
4289·872	+ 7·00	½	....	....	....	....	+10·18	¼	+ 5·50	¼	+12·57	¼	+2·89	¼
4215·906	+18·85	¼	....	....	....	....	....	....	− 0·90	¼	− 1·22	¼	+1·06	¼
Weighted mean	+ 7·18		+ 11·08		+ 2·75		+ 9·32		+ 3·17		+ 2·75		+ 5·50	
V_a	− 11·94		− 12·57		− 12·91		− 13·08		− 12·88		− 12·29		− 11·42	
V_d	− 0·04		− 0·18		− 0·10		− 0·11		− 0·12		− 0·14		− 0·16	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 5·1		− 2·0		− 10·5		− 4·1		− 10·1		− 10·0		− 6·4	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	7455		7474		7488		7492		7555		7620		7630	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	+20·46	½	+14·87	½	+ 2·48	¼	− 3·24	¼	−12·41	½	− 3·30	¼	− 4·21	¼
4549·646	+ 9·18	¼	+21·12	¼	− 5·77	¼	+ 9·57	¼	−16·66	¼	+ 0·95	¼	+ 0·81	¼
4523·052	+19·51	¼	+ 7·82	¼	+24·53	½	+ 6·54	½	+ 2·41	¼	− 4·95	¼	−10·59	¼
4501·865	+14·25	¼	− 4·65	½	+ 8·31	¼	+ 8·59	¼	− 0·20	¼	−12·46	¼	−19·03	¼
4415·200	+24·80	½	+ 9·03	¼	+10·22	¼	....	....	+ 6·28	¼	−12·63	¼	− 0·38	¼
4404·042	+11·20	¼	....	....	− 4·56	¼	....	....	− 1·24	¼	−25·62	¼	+ 5·93	¼
4351·674	+ 3·03	¼	+ 2·69	¼	− 6·44	¼	....	....	− 4·28	¼	....	....	− 8·56	¼
4340·705	+30·05	½	+11·96	½	−13·26	¼	− 8·68	¼	− 2·74	½	−26·39	½	−13·44	½
4314·891	+ 8·69	½	+ 9·02	½	+ 6·70	½	....	....	− 0·72	¼	−14·50	½	−10·88	½
4294·514	....	....	+14·27	¼	....	....	....	....	....	....	....	....	+ 0·85	¼
4289·872	+11·71	¼	+ 4·30	¼	....	....	....	....	− 6·79	½	−10·32	¼	−13·13	¼
4271·888	+11·61	½	....	....	....	....	....	....	....	....	....	....	....	....
4215·906	+10·14	¼	+12·72	¼	....	....	....	....	− 1·38	¼	−29·96	¼	− 0·88	¼
Weighted mean	+ 15·89		+ 8·98		+ 2·93		+ 2·32		− 4·26		− 15·01		− 6·99	
V_e	− 10·44		− 9·55		− 7·03		− 4·78		+ 6·06		+ 11·17		+ 12·25	
V_d	− 0·16		− 0·20		− 0·21		− 0·24		+ 0·16		+ 0·12		+ 0·14	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 5·0		− 1·0		− 4·6		− 3·0		+ 1·7		− 4·0		+ 5·1	

MEASURES OF 32 o^2 CYGNI—*Continued*

λ	7663		7679		7696		7701		7712		7719		7730	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	− 4·21	½	+ 3·76	½	+ 2·30	¼	−10·31	½	−24·36	½	−25·55	¼	−19·18	¼
4549·646	−11·07	¼	− 0·88	¼	+10·26	¼	−18·68	¼	−29·98	¼	+ 1·34	¼	− 3·50	¼
4523·052	+ 4·67	¼	− 2·00	½	+ 1·33	¼	+ 4·82	¼	− 4·69	¼	− 9·95	¼	− 7·12	¼
4501·865	− 5·26	¼	− 8·06	½	−13·47	¼	− 3·38	¼	−34·44	¼	− 2·75	¼	−11·46	½
4415·200	− 2·27	½	+ 2·48	½	....	....	+ 0·34	¼	−18·34	½	−12·02	½	−10·60	¼
4404·042	....	....	−17·33	½	+ 7·81	¼	−12·25	¼	− 5·76	¼	−16·97	¼	....	....
4351·674	....	....	....	....	....	....	−17·62	¼	....	....	....	....	−12·30	¼
4340·705	−24·36	½	− 4·66	½	−13·22	¼	− 6·69	½	− 4·89	¼	−13·66	½	−12·54	½
4314·891	−16·40	½	− 4·92	½	−11·12	¼	−12·01	½	+18·20	½	− 5·72	½	−14·76	½
4294·514	+ 0·44	¼	− 9·46	¼	....	....	−20·54	¼	−13·15	¼	−10·02	¼	−31·08	¼
4289·872	....	....	−11·08	¼	....	....	....	....	....	....	....	....	....	....
4215·906	....	....	− 6·28	¼	....	....	....	....	+13·91	¼	....	....	− 0·36	¼
Weighted mean	− 8·80		− 5·39		− 2·30		− 9·64		− 9·84		− 10·56		− 12·78	
V_a	+ 12·96		+ 12·49		+ 11·63		+ 10·82		+ 9·84		+ 8·94		+ 7·67	
V_d	+ 0·19		+ 0·18		+ 0·10		+ 0·05		− 0·09		− 0·09		+ 0·07	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 3·9		+ 7·0		+ 9·1		+ 0·9		− 0·4		− 2·0		− 5·3	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	7746		7763		7781		7800		7812		7821		7835	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	−15·30	½	+ 7·46	¼	−14·56	½	− 2·74	¼	− 0·50	¼	+ 5·60	¼	− 0·37	½
4549·646	− 8·47	¼	− 5·58	¼					+15·97	¼	+10·09	¼	−17·36	½
4523·052	− 4·56	½	+ 1·34	¼	−11·82	½			+ 8·01	¼	− 0·97	¼	+11·35	¼
4501·865	−13·73	¼	+ 0·53	¼	− 8·59	¼			+ 0·44	¼			+ 9·54	¼
4415·200			+ 1·28	¼			+ 0·10	¼	+15·09	¼			+16·64	¼
4404·042	−27·70	¼	+ 1·22	¼			−12·02	¼	+ 9·71	¼			− 2·97	¼
4351·674	−14·92	¼			−23·46	¼	− 9·26	¼	− 8·35	¼	−14·03	¼	−10·19	¼
4340·705	− 7·81	½	+ 8·84	¼	− 5·23	¼	+ 1·03	½	+ 4·23	½			− 7·48	½
4314·891	− 6·51	¼	−18·83	½	− 6·50	½	+ 2·00	½	+ 3·22	½	− 6·59	¼	− 1·97	½
4294·514	−26·29	¼	−16·84	¼	−11·63	½								
4289·872									+ 9·39	¼			− 0·79	¼
4215·906			+10·26	½					+ 7·41	¼				
Weighted mean	− 12·75		− 1·59		− 11·48		− 2·22		+ 5·54		− 1·18		− 2·20	
V_a	+ 6·58		+ 4·26		+ 1·33		− 2·10		− 5·45		− 7·55		− 8·60	
V_d	− 0·10		− 0·10		− 0·12		+ 0·04		± 0·00		+ 0·02		− 0·02	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 6·6		+ 2·3		− 10·5		− 4·6		− 0·2		− 9·0		− 11·1	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	7864		7897		7903		7929		8129		8157		8168	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	+ 6·53	¼	+ 8·91	¼	− 6·96	¼	+15·54	½	− 1·77	½	−36·26	½	−19·74	½
4549·646	....	....	− 3·10	¼	−16·52	¼	+13·38	½	−34·76	¼	−20·72	½	−35·12	¼
4523·052	+17·00	¼	+ 8·17	¼	+ 1·64	¼	− 5·45	¼	−16·76	¼	−16·89	½	....	....
4501·865	− 2·22	¼	− 5·77	¼	+ 0·20	¼	+ 2·21	¼	−13·40	¼	−21·65	½	−31·16	¼
4415·200	....	....	....	....	....	....	....	....	−22·62	¼	−18·33	¼	−34·78	½
4404·042	....	....	....	....	....	....	....	....	....	....	− 7·88	¼	−29·04	½
4351·674	+ 1·78	¼	+ 3·92	¼	− 3·48	¼	− 4·38	¼	....	....	−37·15	¼	−27·42	¼
4340·705	−10·96	½	....	....	+ 6·31	¼	+ 5·74	¼	−11·45	¼	−34·74	½	−37·30	½
4314·891	+ 3·11	¼	− 3·50	¼	+ 4·20	¼	+ 5·71	¼	....	....	−31·80	½	−25·85	½
4294·514	....	....	....	....	....	....	....	....	....	....	−30·30	½	−43·80	¼
4289·872	....	....	....	....	....	....	....	....	....	....	−36·82	¼	−25·48	¼
4215·906	....	....	....	....	....	....	....	....	....	....	−47·82	½	−20·47	¼
Weighted mean	+ 2·54		+ 1·44		− 2·09		+ 6·85		− 14·65		− 29·04		− 29·80	
V_a	− 9·72		− 12·92		− 13·08		− 11·87		+ 7·68		+ 11·54		+ 12·69	
V_d	− 0·04		− 0·05		− 0·14		− 0·12		+ 0·19		+ 0·10		+ 0·09	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 7·5		− 11·8		− 15·6		− 5·4		− 7·1		− 17·7		− 17·3	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	8189 Vel.	8189 Wt.	8196 Vel.	8196 Wt.	8204 Vel.	8204 Wt.	8212 Vel.	8212 Wt.	8215 Vel.	8215 Wt.	8224 Vel.	8224 Wt.	8230 Vel.	8230 Wt.
4571·896	−37·50	½	−31·10	½	−15·26	½	−25·58	½	−18·92	½	−21·04	½	−20·13	½
4549·646	−21·15	¼	−35·15	¼	−20·22	¼	−20·22	½	−26·54	¼	−15·82	½	− 3·63	½
4523·052	−27·52	½	−26·22	¼	−30·99	½	−33·05	¼	−21·75	½	−11·10	½	−14·31	½
4501·865	−45·81	¼	−27·62	¼	−30·90	¼	−43·16	¼	−31·16	¼	−32·30	¼	−18·39	¼
4415·200	−46·31	¼	......	......	−34·88	¼	−36·21	¼	−13·71	¼	−24·55	¼	−27·40	½
4404·042	−23·10	¼	......	......	......	......	−26·42	¼	−20·04	¼	......	......	−18·75	½
4340·705	−39·24	½	−30·00	½	......	......	−31·69	¼	−27·18	½	−40·48	½	−20·98	½
4314·891	−21·98	¼	−32·22	¼	−34·35	½	−23·30	½	−29·12	½	−12·78	¼	−18·65	½
4294·514	−38·26	¼	......	......	......	......	−32·83	¼	−30·12	¼	......	......	−15·76	¼
4289·872	......	......	......	......	......	......	......	......	−49·76	½	......	......	......	......
4215·906	......	......	......	......	......	......	......	......	−24·04	¼	......	......	......	......
Weighted mean	− 33·76		− 30·43		− 27·47		− 28·46		− 27·44		− 22·41		− 16·96	
V_a	+ 12·54		+ 11·28		+ 10·94		+ 10·09		+ 9·13		+ 7·36		+ 6·63	
V_d	+ 0·05		− 0·03		− 0·03		− 0·05		− 0·09		+ 0·04		− 0·05	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 21·9		− 19·4		− 16·8		− 18·7		− 18·7		− 15·3		− 11·7	

MEASURES OF 32 θ^2 CYGNI—*Continued*

λ	8242		8248		8261		8270		8271		8277		8284	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	−19·34	½	−25·56	½	−29·30	½	−10·31	¼	−34·42	¼	−16·28	½	−26·89	½
4549·646	− 3·37	¼	−26·63	½	−32·92	¼	−23·38	¼	−32·00	¼	−21·92	¼	−12·00	¼
4523·052	−24·32	½	−20·85	½	−28·42	½	−26·12	¼	−32·66	¼	−19·60	¼	− 7·64	¼
4501·865	−44·56	¼	−36·98	¼	−22·97	¼	−22·94	¼	−35·34	¼	−26·86	½	−24·84	½
4415·200	−17·05	¼	−29·41	¼	−21·56	¼	−18·59	¼	......	......	−13·00	¼	− 6·93	¼
4404·042	......	......	......	......	−23·58	¼	......	......	......	......	−16·15	½	−21·58	½
4340·705	−27·18	½	−16·15	¼	−19·41	¼	−11·98	¼	−27·19	¼	−26·61	½	−17·38	½
4314·891	−15·89	½	−19·78	½	−17·97	½	−21·40	¼	−32·99	¼	−18·10	½	−21·74	½
4294·514	......	......	......	......	−24·12	¼	......	......	......	......	−18·91	½	......	......
4289·872	......	......	......	......	......	......	......	......	......	......	−22·99	¼	−21·59	¼
4215·906	......	......	......	......	......	......	......	......	......	......	−22·11	¼	......	......
Weighted mean	− 21·68		− 24·38		− 24·66		− 19·25		− 32·43		− 20·32		− 19·50	
V_a	+ 5·50		+ 4·55		+ 3·08		+ 0·32		+ 0·07		− 2·08		− 3·57	
V_d	− 0·09		− 0·10		− 0·11		− 0·03		− 0·17		− 0·12		− 0·10	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 16·5		− 20·2		− 22·0		− 19·2		− 32·8		− 22·8		− 23·4	

MEASURES OF 32 θ^2 CYGNI—*Concluded*

λ	8299		8302		8327		8353		8402					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·896	− 3·15	½	−16·93	½	−39·21	½	−38·01	½	−19·50	½	......	...	......	...
4549·646	− 4·15	¼	−19·32	½	−28·29	¼	−29·52	½	−25·32	½	......	...	......	...
4523·052	−19·06	½	− 9·30	¼	−20·38	¼	−24·37	½	−19·22	½	......	...	......	...
4501·865	−20·68	¼	−14·10	¼	−32·95	¼	−21·52	¼	−28·89	½	......	...	......	...
4415·200	−13·59	¼	− 9·06	¼	−47·15	¼	−34·95	¼	−23·95	¼	......	...	......	...
4404·042	−29·85	¼	−15·20	¼	−28·32	¼	−20·58	¼	−23·76	¼	......	...	......	...
4340·705	−11·20	¼	−20·88	½	−37·59	¼	−50·02	½	−31·58	½	......	...	......	...
4314·891	−21·65	½	−22·30	½	−26·25	¼	−25·45	½	−38·90	½	......	...	......	...
4294·514	......	...	−18·48	½	......	...	−36·40	½	−28·99	¼	......	...	......	...
4289·872	−25·18	¼	......	...	......	...	−24·42	¼	......	...	......	...	......	...
4271·888	......	...	......	...	......	...	......	...	−20·78	¼	......	...	......	...
4215·906	......	...	−11·59	¼	......	...	......	...	......	...	......	...	......	...
Weighted mean	− 16·03		− 17·00		− 33·26		− 31·81		− 26·52					
V_a	− 5·00		− 6·97		− 10·67		− 12·97		− 10·15		......		......	
V_d	− 0·04		− 0·09		− 0·09		− 0·14		− 0·16		......		......	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		......		......	
Radial Velocity	− 21·4		− 24·3		− 43·3		− 45·2		− 37·1		......		......	

The plates were grouped into twelve normal places found in Table V.

TABLE V

No.	Julian Day	Phase	Velocity	Weight	Residual
1	2,420,510·835	795·708	−30·1	4	−1·6
2	543·658	867·018	−35·4	3	+0·2
3	495·178	964·788	−33·6	1	−2·1
4	629·599	1099·209	−13·1	1·5	+0·8
5	716·627	16·237	− 7·8	2	+1·3
6	801·337	100·947	− 5·9	2	±0·0
7	882·701	182·311	− 1·4	1	−2·1
8	2,421,007·588	307·198	+ 3·7	1	−1·9
9	076·982	376·592	− 3·4	1·5	−1·7
10	166·664	466·274	−10·1	1	+4·5
11	2,240,272·465	635·711	−14·9	2	+1·6
12	2,421,443·212	742·822	−20·1	2	+1·6

A curve running through the normal places has some similarity to that which would be given by the blending of the lines of the primary star by those of a secondary star, but the deviation from the elliptic form takes place unsymmetrically in such a way as to be hardly thus accountable. Also, there seems to be no widening of the lines at any place in the orbit and it seems as though the irregularities in the curve are due to actual variations in the motion of the light-giving body. It was therefore attempted to run an elliptical curve, as closely as possible, through the normal places and apply a secondary correction to this by introducing a circular curve of one-third the period.

A least-squares solution was carried through, which resulted in slight corrections to the elements and a reduction of the value of Σpvv from 75 to 60. The preliminary and final values of the elements are given below. Probable errors were computed and are appended to the final values.

Element	Preliminary	Final
P	1170 days	1170 days
e	0·2	0·182 ±0·053
ω	280°	281°·05 ±4°·8
K	16 km	16·64 km. ±0·93 km.
T	2,420,700·25 J.D.	2,420,700·39 J.D. ±18·7 d.
γ	−14·6 km	−14·35 km. ±0·65 km.
K_1	6 km	5·86 km. ±0·90 km.
T_1	2,420,515 J.D.	2,420,515·821 J.D. ±12·4 d.
$a \sin i$		263,250,000 km.
$\frac{m_1^3 \sin^3 i}{(m_1+m)^2}$		0·53 ⊙

To explain the curves one would have to consider the system as consisting of a light-giving body revolving about another body in a circular orbit in 390 days and these two about a third in an elliptic orbit in 1170 days (fig. 2).

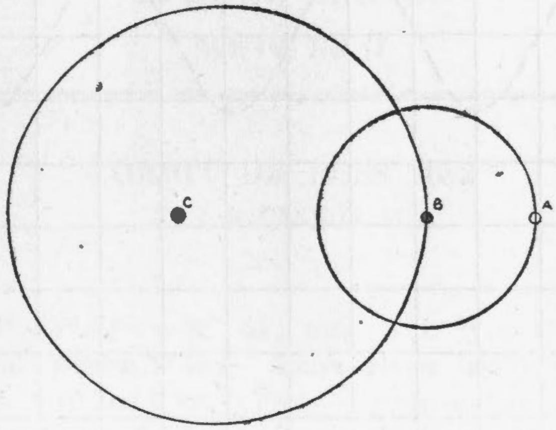


Fig. 2

In fig. 1 the single circles represent the Ottawa normal places, the double circles Küstner's observations, and the triple circles the Lick observations.

Dominion Observatory
Ottawa
February, 1918.

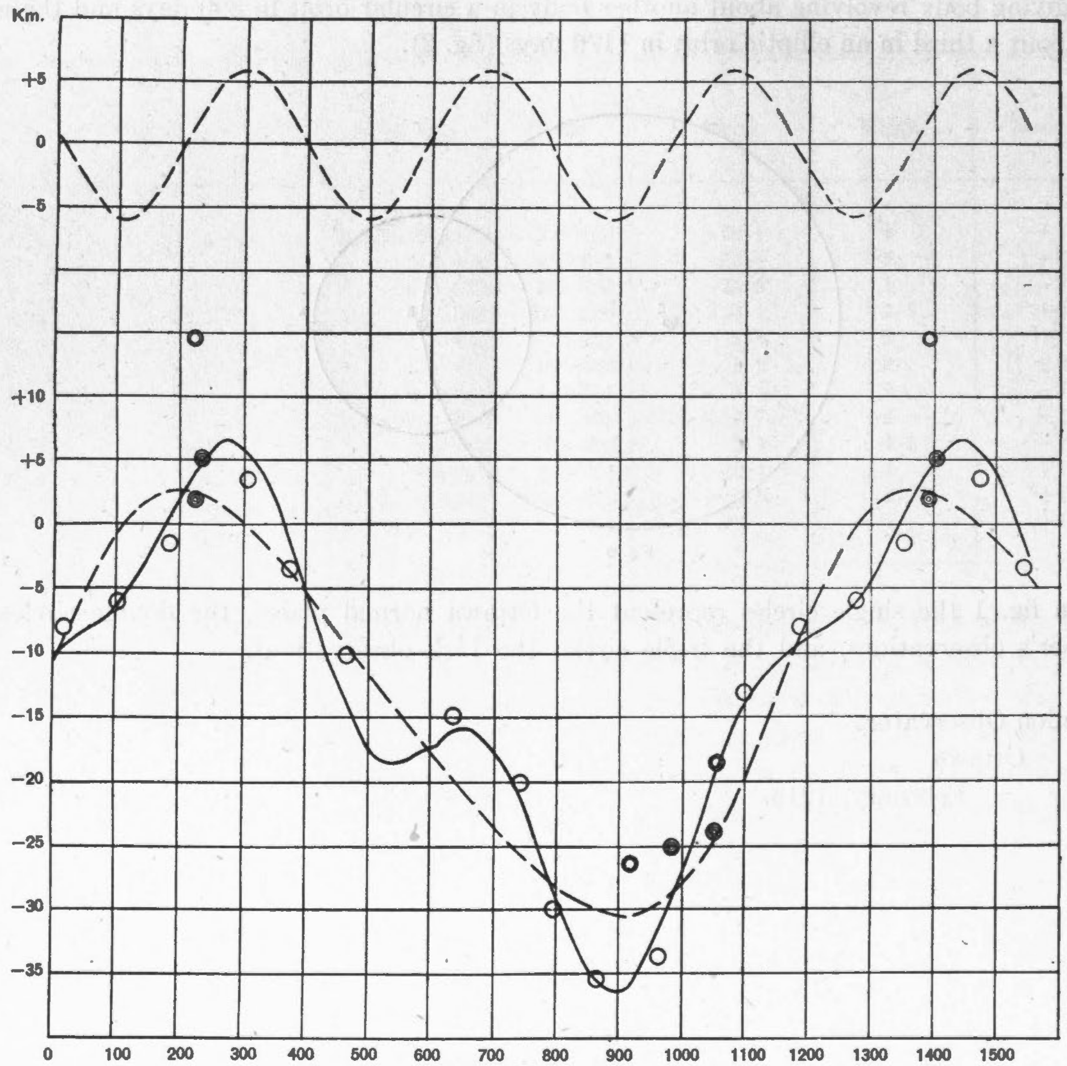


Fig. 1—Radial Velocity Curve of 32 β^2 Cygni

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 11

ORBIT OF BOSS 1082

BY J. B. CANNON, M.A.

Boss 1082 ($\alpha=4^h\ 33^m$, $\delta=+52°\ 54'$, mag. 5·3, type G5) was found to be a spectroscopic binary at Mount Wilson. Three plates taken there in 1914 and 1915 gave velocities of −38, −66 and 0 km. Forty-two plates were taken here in 1916, 1917 and 1918, and from these the following orbit was obtained.

The Mount Wilson observations follow. They lie on an average about 6 km. more positive than our observations and if this amount be subtracted from each observation they fit the curve fairly well.

MOUNT WILSON OBSERVATIONS

Date	Julian Day	Phase	Velocity	Residual
1914, Dec. 2·820	2,420,469·820	58·27	−38 km.	+ 6·0 km.
" 24·786	491·786	80·24	−66	+ 1·2
1915, Mar. 2·646	559·646	27·10	0	+12·2

The lines used are given in the table below, the wave-lengths being found by means of corrections obtained from the line-residual in each plate.

4571·970	4415·316	4325·809	4271·775
4549·796	4404·956	4314·919	4233·331
4523·099	4352·165	4294·615	4215·808
4501·794	4340·734	4289·815	4143·776

The observations are as follows:

OTTAWA OBSERVATIONS OF BOSS 1082

Plate	Julian Day	Phase	Velocity	Residual
7819	2,421,132·81	116·26	−38·5	+ 1·5
7833	138·85	1·30	−23·9	+ 7·4
7852	141·82	4·27	−19·2	+ 8·3
7861	143·81	6·25	−33·1	− 8·7
7874	148·81	11·25	−21·9	− 1·8
7894	173·87	36·32	−15·5	+ 1·5
7901	182·76	45·21	−25·0	+ 1·3
7907	188·76	51·21	−41·3	− 7·3
7917	190·63	53·08	−35·2	+ 1·7
7968	227·56	90·01	−61·4	+ 6·6
7992	244·55	107·00	−49·0	+ 4·4
8005	248·51	110·96	−44·8	+ 3·4
8008	251·51	113·96	−40·8	+ 2·3
8018	259·64	1·09	−40·3	− 9·1
8033	262·60	4·05	−31·0	− 3·0
8068	281·57	23·02	−17·0	− 4·8
8075	287·62	29·07	−12·8	+ 0·1
8088	290·52	31·97	−12·1	+ 1·9
8103	297·57	39·02	−20·5	− 1·2
8107	300·58	42·03	−21·2	+ 0·8
8115	304·58	46·02	−29·0	− 4·9
8118	307·58	49·03	−24·8	+ 6·4
8131	317·59	59·04	−47·1	− 2·0
8328	527·86	27·31	−12·0	+ 0·1
8332	537·84	37·29	−18·7	− 1·3
8340	540·84	40·29	−23·4	− 2·8
8350	545·83	45·28	−31·2	− 4·9
8358	547·77	47·22	−32·9	− 3·9
8366	559·84	59·29	−45·7	− 0·3
8369	562·69	62·14	−41·8	+ 7·7
8371	565·62	65·07	−56·6	− 3·5
8377	569·78	69·23	−58·9	− 0·5
8380	574·61	74·06	−59·7	+ 3·2
8389	588·60	88·05	−74·3	− 5·9
8403	593·61	93·06	−72·1	− 5·2
8406	597·58	97·03	−65·6	− 1·2
8432	618·54	117·99	−33·0	− 4·6
8434	621·67	0·12	−41·9	− 9·0
8440	633·59	12·04	−18·3	± 0·0
8441	635·63	14·08	−16·9	− 0·4
8444	642·62	21·07	−10·2	+ 2·1
8455	646·53	24·98	− 4·5	+ 7·6

MEASURES OF BOSS 1082

λ	7819		7833		7852		7852*		7852*		7861		7874	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·970	− 61·8	¼	−40·63	½	−44·10	¼	−58·22	¼	−40·88	¼	−43·62	¼	−37·60	½
4549·796	−49·75	¼	−61·58	¼	−33·49	¼	−33·36	¼	−35·77	¼	−35·20	¼	−46·82	½
4523·099	−65·33	¼	−66·46	¼	−45·92	¼	−60·16	¼	−51·88	.....	.....	.....	.....	.....
4501·794	−55·62	¼	−26·79	¼	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4415·316	−51·22	¼	−38·94	½	−31·58	½	−40·40	¼	−35·29	½	−55·15	¼	−44·20	½
4404·956	−64·34	¼	−44·50	½	−44·42	¼	−49·01	¼	−41·31	½	−59·62	¼	−48·50	½
4352·165	−68·45	¼	.....	.....	.....	.....	.....	.....	.....	.....	−76·02	¼	.....	.....
4340·734	−83·70	¼	−46·60	¼	−49·20	¼	−47·21	¼	−36·82	¼	−73·20	¼	−43·58	¼
4325·809	.....	.....	−56·20	½	−38·22	¼	−35·53	½	.....	.....	.....	.....	−42·22	½
4314·919	−65·90	¼	−48·96	½	−43·22	¼	−41·20	¼	−45·46	½	−50·40	¼	−32·35	¼
4289·815	−58·62	¼	−49·42	¼	−45·22	½	−47·90	½	−47·15	¼	−44·42	¼	−58·42	¼
4271·775	.....	.....	.....	.....	.....	.....	.....	.....	−48·95	¼	.....	.....	.....	.....
4233·331	.....	.....	−49·10	¼	−39·82	¼	−43·21	¼	.....	.....	.....	.....	.....	.....
4215·808	.....	.....	−37·47	¼	−39·18	¼	−28·51	¼	−41·14	¼	−57·10	¼	−26·53	¼
4143·776	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	−57·30	¼	.....	.....
Weighted mean	− 62·47		− 46·93		− 40·86		− 43·61		− 40·51		− 55·20		− 42·82	
V_a	+ 24·19		+ 23·25		+ 22·69		+ 22·69		+ 22·69		+ 22·28		+ 21·13	
V_d	+ 0·10		+ 0·03		+ 0·05		+ 0·05		+ 0·05		+ 0·05		+ 0·05	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 38·5		− 23·9		− 18·4		− 21·1		− 18·0		− 33·1		− 21·9	

* Check measurement

MEASURES OF BOSS 1082—*Continued*

λ	7894		7901		7907		7917		7968		7992		8005	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·970	−30·01	½	−43·50	¼	−48·02	¼	−45·20	½	−56·20	¼	−39·15	¼	−22·62	¼
4549·796	....	....	−27·44	¼	−57·10	¼	−42·63	¼	....	....	−24·42	½	−31·00	¼
4523·099	−24·85	⅓	....	....	....	....	−45·00	¼	−29·58	⅓	−20·20	¼	....	....
4501·794	−35·13	⅓	− 2·70	½	−40·67	½	−67·97	½	....	....	....	....	....	....
4415·316	....	....	−46·60	¼	....	....	−52·04	½	−55·25	¼	−50·95	½	−25·25	½
4404·956	....	....	−30·85	½	−54·16	½	−33·30	¼	−64·60	½	−32·82	¼	....	....
4352·165	−20·53	¼	....	....	....	....	....	....	....	....	....	....	−26·98	¼
4340·734	−24·12	¼	−51·10	½	−39·56	¾	−25·90	½	−50·75	¼	−17·18	¼	−33·25	¼
4325·809	....	....	−37·00	⅓	....	....	....	....	−49·80	¼	....	....	....	....
4314·919	−29·76	¼	....	....	−48·65	½	−28·20	¼	−47·10	¼	−40·95	½	−30·48	½
4294·615	....	....	....	....	....	....	....	....	−42·40	¼	−34·67	½	−16·10	¼
4289·815	....	....	....	....	....	....	−44·38	½	....	....	−27·19	½	....	....
4215·808	....	....	....	....	....	....	....	....	−41·78	¼	....	....	....	....
Weighted mean	− 28·26		− 34·17		− 48·03		− 41·28		− 50·93		− 31·95		− 26·53	
V_a	+ 13·13		+ 9·56		+ 7·01		+ 6·20		− 10·25		− 16·80		− 18·14	
V_d	− 0·11		− 0·09		− 0·03		+ 0·12		+ 0·09		+ 0·05		+ 0·09	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 15·5		− 25·0		− 41·3		− 35·2		− 61·4		− 49·0		− 44·8	

MEASURES OF BOSS 1082—*Continued*

λ	8008		8018		8033		8068		8075		8088		8103	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·970	−18·66	½	....	....	− 2·38	¼	+ 7·87	¼	+14·00	¼	+14·53	½	+15·46	½
4549·796	−20·62	½	− 8·82	¼	−17·87	¼	+10·26	¼	+13·48	¼	+10·07	¼	+ 3·77	½
4501·794	−19·81	¼	−29·32	¼	− 8·05	¼	+15·13	¼	+14·17	½	+19·06	½	....	....
4415·316	−17·25	½	−10·54	½	− 8·29	¼	+ 7·13	¼	+ 9·39	½	+16·02	½	+ 9·03	½
4404·956	−30·22	½	....	....	....	....	....	....	....	....	....	....	+10·09	½
4352·165	−12·14	¼	....	....	....	....	....	....	....	....	....	....	....	....
4340·734	−15·72	¼	−24·42	¼	−12·43	¼	+19·35	¼	+21·95	½	+ 9·39	¼	+17·31	¼
4314·919	−29·58	½	−16·12	½	− 6·72	½	− 1·07	¼	+ 5·81	½	+ 7·03	½	− 7·50	¼
4289·815	−20·98	¼	−20·31	¼	−11·39	¼	+ 1·02	¼	+14·73	¼	+21·58	¼	+ 0·36	½
4215·808	....	....	−24·35	½	− 0·88	¼	....	....	+14·72	½	+ 4·46	¼	−13·38	¼
Weighted mean	− 21·52		− 18·49		− 8·50		+ 8·53		+ 13·30		+ 13·23		+ 5·68	
V_a	− 19·08		− 21·37		− 22·10		− 25·25		− 25·68		− 25·78		− 25·75	
V_d	+ 0·07		− 0·12		− 0·09		+ 0·04		− 0·18		− 0·09		− 0·16	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 40·8		− 40·3		− 31·0		− 17·0		− 12·8		− 12·1		− 20·5	

MEASURES OF BOSS 1082—*Continued*

λ	8107		8115		8118		8131		8328		8332		8340	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·970	+ 9·61	½	− 3·11	¼	− 2·71	¼	−30·08	½	−23·44	¼	−42·46	¼	−46·43	½
4549·796	− 4·48	¼	−17·81	¼	....	....	−25·10	½	−11·58	¼	−28·11	¼	−45·92	¼
4415·316	+ 5·30	½	− 1·60	½	+ 2·21	½	−18·08	½	−32·30	½	−27·05	½	−31·22	½
4404·956	+ 4·62	¼	− 2·35	½	− 5·60	¼	−17·06	½	−37·58	¼	−25·01	½	−40·79	½
4340·734	+13·49	¼	+ 5·72	¼	+ 8·53	¼	−10·05	½	−28·82	¼	−24·54	½	−30·19	½
4314·919	+ 8·62	¼	− 5·74	½	− 0·21	¼	−20·72	½	−30·47	¼	−28·90	¼	−33·68	½
4294·615	....	....	....	....	....	....	....	....	....	....	−41·54	½	−34·99	¼
4289·815	−11·42	¼	+15·12	¼	....	....	−28·60	¼	−31·10	¼	−36·10	½	−38·16	½
4233·331	....	....	....	....	....	....	....	....	−29·97	½	−35·68	½	−22·37	½
4215·808	+ 7·76	¼	−15·72	¼	....	....	−37·89	¼	....	....	....	....	....	....
Weighted mean	+ 4·84		− 3·20		+ 0·74		− 22·05		− 28·75		− 31·95		− 35·53	
V_a	− 25·63		− 25·35		− 25·06		− 24·54		+ 17·15		+ 13·62		+ 12·46	
V_d	− 0·16		− 0·14		− 0·18		− 0·20		− 0·09		− 0·09		− 0·09	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 21·2		− 29·0		− 24·8		− 47·1		− 12·0		− 18·7		− 23·4	

MEASURES OF BOSS 1082—*Continued*

λ	8350		8358		8366		8369		8371		8377		8380	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·970	−30·09	¼	−39·15	½	−41·80	½	−54·76	½	....	....	−63·04	¼	−54·82	
4549·796	−35·44	½	−48·06	¼	−53·30	½	−45·03	½	....	....	−68·90	¼	−55·90	½
4533·099	−47·61	¼	−34·70	¼	−66·00	¼	....	....	....	....	−53·79	½	−57·91	½
4415·316	−44·25	½	−50·60	¼	−49·87	½	−42·01	¼	−43·91	¼	−59·30	¼	−58·60	¼
4404·956	−56·43	¼	−27·13	¼	−47·09	½	−30·69	¼	−68·21	¼	−53·60	¼	−47·55	¼
4340·734	−34·70	¼	−35·29	¼	−55·86	¼	−52·24	½	−82·85	¼	−68·22	¼	−58·72	¼
4314·919	−43·22	¼	−49·57	¼	−51·42	½	−33·16	¼	−37·22	¼	−60·98	¼	−71·78	¼
4294·615	....	....	−48·65	¼	−42·32	¼	....	....	....	....	....	....	....	¼
4289·815	....	....	....	....	−53·00	¼	....	....	....	....	−54·25	¼	....	....
4233·331	−41·58	¼	−50·38	¼	−41·99	¼	....	....	−50·14	¼	....	....	....	....
														....
Weighted mean	− 41·30		− 42·27		− 49·74		− 44·71		− 56·47		− 58·43		− 57·33	
V_a	+ 10·47		+ 9·66		+ 4·44		+ 3·17		+ 0·01		− 0·04		− 2·23	
V_d	− 0·09		− 0·03		− 0·14		+ 0·03		+ 0·10		− 0·11		+ 0·09	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 31·2		− 32·9		− 45·7		− 41·8		− 56·6		− 58·9		− 59·7	

MEASURES OF BOSS 1082—*Continued*

λ	8389		8403		8406		8432		8434		8440		8441	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·970	−62·15	½	−75·60	¼	−56·25	½	−31·62	½	−22·50	½	+13·06	½	+ 5·74	½
4549·796	−62·72	¼	−57·21	½	−50·40	½	−29·40	½	−22·99	½	− 7·77	¼	+ 9·02	½
4533·099	−68·70	½	−52·50	¼	−50·02	¼	+14·38	¼	−19·25	½	− 1·99	¼	+16·94	½
4501·794					−60·61	¼	−34·04	½	−11·70	¼			+ 2·29	¼
4415·316	−87·78	¼			−42·83	½	− 3·75	¼	−32·91	¼			+ 9·64	½
4404·956	−69·32	¼	−75·55	¼	−67·68	¼	−25·09	½					+14·72	½
4340·734	−55·85	½	−60·62	¼	−50·20	½			−14·58	¼			−12·96	¼
4314·919	−52·05	½	−50·05	¼	−48·75	½	+ 8·45	½			+10·58	¼	+ 3·58	½
4294·615	−65·88	¼	−57·48	¼	−58·58	¼	− 7·16	¼						
4289·815													+12·23	¼
4233·331	−76·75	½												
4215·808	−58·41	¼											− 4·56	¼
Weighted mean	− 65·66		− 61·29		− 53·15		− 13·14		− 20·96		+ 5·39		+ 7·27	
V_a	− 8·45		− 10·58		− 12·21		− 19·61		− 20·52		− 23·34		− 23·72	
V_d	+ 0·07		+ 0·02		+ 0·04		+ 0·03		− 0·14		− 0·04		− 0·14	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 74·3		− 72·1		− 65·6		− 33·0		− 41·9		− 18·3		− 16·9	

MEASURES OF BOSS 1082—*Concluded*

λ	8444		8455											
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4571·970	+26·65	½	+17·46	½										
4549·796	+16·51	½	+33·68	½										
4533·099	− 0·32	¼	+42·04	¼										
4501·794	+18·15	¼	+26·52	¼										
4415·316	+11·18	½	+17·64	½										
4404·956	+ 5·94	¼												
4340·734	+13·12	¼	+ 3·17	½										
4314·919	+13·90	½	+19·96	½										
4233·331	+21·42	¼												
Weighted mean	+ 14·98		+ 21·03											
V_a	− 24·79		− 25·22											
V_d	− 0·14		− 0·05											
Curv.	− 0·28		− 0·28											
Radial Velocity	− 10·2		− 4·5											

The observations were grouped into twelve normal places.

NORMAL PLACES

No.	Julian Day	Phase	Velocity	Residual	Weight
1	2,421,372·84	118·28	− 38·9	− 1·8	2
2	171·77	3·97	− 26·8	+ 0·6	2
3	472·67	12·46	− 19·0	− 1·3	1
4	524·65	24·10	− 10·9	+ 1·2	2
5	250·67	32·45	− 13·5	+ 1·0	1
6	419·21	39·66	− 20·9	− 0·5	2
7	344·39	45·51	− 28·3	− 1·2	1
8	308·68	50·13	− 33·5	− 0·3	2
9	480·04	60·16	− 44·9	+ 2·3	1
10	570·01	69·46	− 58·4	+ 0·3	1
11	501·84	92·04	− 68·3	− 1·0	2
12	246·53	108·98	− 46·9	+ 4·0	1

Preliminary values for the elements were found graphically.

P = 121 days
e = ·05
ω = 280°
K = 29 km.
γ = −40·35 km.
T = J.D. 2,421,136·05

A least-squares solution was carried through giving the following corrections:—

$\delta\gamma$ = − ·12 km.
δK = − ·81 km.
δe = − ·031
$\delta\omega$ = +5°
δT = +1·5 days

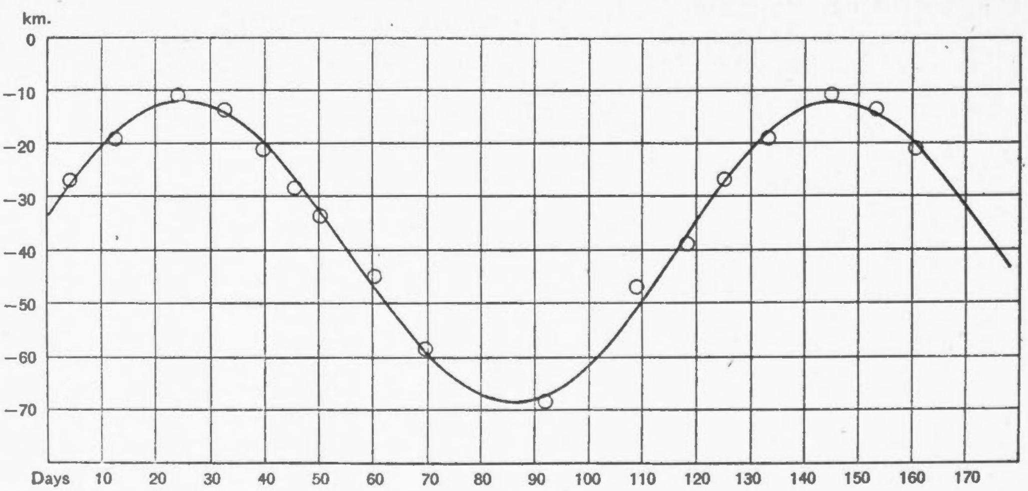
This gave the final values of the elements to which are appended the probable errors:—

P = 121 days		
K = 28·19 km.	±	1·2 km.
e = ·019	±	·042
ω = 285°	±	42°·68
γ = −40·47 km.	±	·81 km.
T = J.D. 2,421,137·55	±	14·26 days

$a \sin i$ = 46,900,000 km.

$$\frac{m_1^3 \sin^3 i}{(m+m_1)^2} = \cdot 28 \odot$$

Dominion Observatory
Ottawa
March, 1918.



Radial Velocity Curve of Boss 1082

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 12

THE SPECTROSCOPIC BINARY BOSS 1275

BY J. B. CANNON, M.A.

Boss 1275 ($\alpha = 5^h\ 16^m$, $\delta = +29°\ 29'$, spectral type A, mag. 5·7) was discovered to be a spectroscopic binary at Mount Wilson, and the measures of six plates were sent by Dr. Adams to this observatory in October, 1916. Of these, two plates showed the components separated and the other four the spectra were superposed giving one measure.

Forty plates were taken here. The lines appearing were:—

4572·156	(1)	4260·640	(1)
4549·766	(28)	4233·328	(4)
4522·871	(1)	4202·161	(1)
4481·400	(40)	4198·494	(1)
4383·720	(5)	4143·928	(3)
4340·634	(27)	4101·890	(1)
4289·915	(3)	4045·975	(2)
4271·760	(2)	3933·825	(12)

The observations follow:—

OTTAWA OBSERVATIONS OF BOSS 1275

Plate	Julian Day	Phase	V_1	R_1	V_2	R_2	V
7832	2,421,138·79	24·23	+100·1	− 6·0	−139·5	− 7·5	....
7845	140·81	26·23	+ 98·7	−28·3	−118·1	+36·9	....
7853	141·89	27·23	+129·6	+ 5·6	−137·1	+ 4·9	....
7862	143·75	1·75	....	....	....	....	−23·0
7886	167·81	25·83	+128·7	+ 1·7	−129·3	+22·7	....
7893	173·80	4·40	....	....	....	....	−23·2
7918	190·70	21·30	....	....	....	....	+19·8
7960	217·85	20·90	....	....	....	....	−21·5
7969	227·63	3·30	....	....	....	....	−10·8
8009	251·58	0·90	+ 91·7	+ 6·7	−149·4	−37·4	....
8010	251·64	0·96	+ 88·8	+ 6·8	−114·1	− 6·1	....
8016	259·52	7·80	−127·0	−31·0	+ 53·6	−14·4	....
8017	259·58	7·86	−111·1	−14·1	+ 64·7	− 4·3	....
8032	262·54	10·80	−114·1	− 9·1	+127·6	+51·1	....
8037	266·53	14·80	−100·6	−20·6	+ 66·6	+15·6	....
8040	270·67	18·90	....	....	....	....	−27·3

OTTAWA OBSERVATIONS OF BOSS 1275—*Concluded*

Plate	Julian Day	Phase	V_1	R_1	V_2	R_2	V
8043	2,421,271·51	19·90					−26·8
8053	272·74	21·00					−31·7
8056	274·66	22·90					−47·8
8089	290·52	11·40	−126·5	−23·0	+52·2	−22·8	
8102	297·51	18·40					−10·5
8106	300·51	21·40					+11·9
8113	303·61	24·43	+ 45·9	−64·1	−122·7	+13·3	
8117	307·52	0·90	+ 97·7	+11·7	−108·2	+ 3·8	
8130	318·53	11·90	− 93·7	+ 7·8	+148·8	+75·0	
8325	517·88	19·30					−27·3
8329	527·92	1·90	+ 70·8	+22·8	− 58·5	+17·5	
8333	537·91	11·90	−104·7	− 3·0	+ 85·3	+10·8	
8341	540·90	14·90	− 88·9	−10·9	+ 81·6	+30·6	
8372	565·69	12·24	−111·8	−11·8	+127·5	+55·3	
8376	569·74	15·69					−47·3
8381	574·69	21·24	+ 75·2	+43·2	− 70·8	−10·8	
8407	597·65	16·77					−49·6
8417	599·68	18·80					− 9·5
8433	621·60	13·29	− 64·8	−39·2	+ 79·6	+ 4·3	
8456	646·59	10·85	−128·3	−23·3	+ 90·3	+14·3	
8464	656·62	20·88					−22·8
8468	663·62	0·45	+121·7	+20·2			
8490	688·55	15·38	+111·6	+67·6	−125·5	−52·5	
8496	693·57	2·97					−34·2

MEASURES OF BOSS 1275

λ	7832 p.*		7832 s.*		7845 p.		7845 s.		7853 p.		7853 s.		7862	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	+ 65·38	½	−201·20	½	....	....	....	....	+ 91·50	½	−177·60	½	− 25·72	½
4481·400	+ 72·02	½	−180·30	½	+ 52·10	½	−164·20	½	+121·60	½	−157·70	½	− 73·62	½
4340·634	+ 79·70	½	−120·40	½	+ 90·40	½	−126·90	½	+ 94·40	½	−157·25	½	....	....
Weighted mean	+ 72·37		−167·30		+ 71·25		−145·55		+102·50		−164·18		− 49·67	
V_a	+ 27·89		+ 27·89		+ 27·58		+ 27·58		+ 27·36		+ 27·36		+ 26·97	
V_d	+ 0·16		+ 0·16		+ 0·14		+ 0·14		± 0·00		± 0·00		+ 0·02	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+100·1		−139·5		+ 98·7		−118·1		+129·6		−137·1		− 23·0	

*p. = primary
s. = secondary

MEASURES OF BOSS 1275—*Continued*

λ	7886 p.		7886 s.		7893		7918		7960		7969		8009 p.	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572·156	+110·20	½	−156·40	½	....		....		....		....		....	
4549·766	+ 91·20	½	−132·60	½	− 46·15	½	+ 26·88	½	− 15·11	½	− 0·92	½	....	
4522·871	....		....		− 34·20	½	....		....		....		....	
4481·400	+ 63·60	½	−191·40	½	− 41·18	½	+ 7·38	½	− 9·26	½	+ 4·64	½	+130·00	½
4340·634	+158·90	½	−118·60	½	....		+ 11·08	½	....		− 7·00	½	+119·80	½
4101·890	....		....		....		− 2·03	½	....		....		....	
3933·825	....		....		....		....		....		− 1·03	½	+ 86·20	½
Weighted mean	+108·48		−149·75		− 40·51		+ 10·14		− 16·82		− 1·33		+112·00	
V_a	+ 19·93		+ 19·93		+ 17·55		+ 9·83		− 4·18		− 9·20		− 20·03	
V_d	+ 0·02		+ 0·02		+ 0·01		+ 0·11		− 0·23		+ 0·04		+ 0·04	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+128·7		−129·3		− 23·2		+ 19·8		− 21·5		− 10·8		+ 91·7	

MEASURES OF BOSS 1275—*Continued*

λ	8009 s.		8010 p.		8010 s.		8016 p.		8016 s.		8017 p.		8017 s.	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	....	....	+ 76·62	¼	−103·40	¼	−110·40	¼	+ 75·00	¼	....	....	....	....
4481·400	−100·10	¼	+104·10	¼	−113·80	¼	− 90·60	¼	+ 93·70	¼	−117·60	¼	+ 69·10	¼
4340·634	− 70·98	¼	+110·40	¼	−103·30	¼	−109·10	¼	+ 56·78	¼	− 58·10	¼	+106·75	¼
4271·760	....	....	+125·80	¼	−107·70	¼	....	....	....	....	....	....	....	....
4260·640	....	....	+129·20	¼	− 78·18	¼	....	....	....	....	....	....	....	....
4202·161	....	....	+136·20		− 66·04	¼	....	....	....	....	....	....	....	....
4143·928	....	....	....	....	....	....	− 73·90	¼	+ 72·70	¼	....	....	....	....
4045·975	....	....	....	....	....	....	−135·60	¼	+ 85·30	¼	....	....	....	....
3933·825	−111·30	¼	+ 81·80	¼	− 84·00	¼	....	....	....	....	....	....	....	....
Weighted mean	−129·06		+109·16		− 93·77		−103·92		+ 76·70		− 87·85		+ 87·92	
V_a	− 20·03		− 20·03		− 20·03		− 22·91		− 22·91		− 22·91		− 22·91	
V_d	+ 0·04		− 0·07		− 0·07		+ 0·07		+ 0·07		− 0·04		− 0·04	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	−149·4		+ 88·8		−114·1		−127·0		+ 53·6		−111·1		+ 64·7	

MEASURES OF BOSS 1275—*Continued*

λ	8032 p.		8032 s.		8037 p.		8037 s.		8040		8043		8053	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	− 84·35	¼	+176·10	¼	− 80·10	¼	+ 91·85	¼	+ 21·64	¼	......	......	− 12·46	¼
4481·400	− 94·10	¼	+136·40	¼	− 77·55	¼	+101·10	¼	− 19·52	¼	− 11·26	¼	− 4·68	½
4340·634	− 91·60	¼	+142·80	¼	− 83·00	¼	+ 70·10	¼	− 3·92	¼	− 1·13	¼	− 4·18	¼
4289·915	......	......	......	......	− 63·52	¼	+106·60	¼	......	......	+ 21·20	¼	+ 16·10	¼
4233·328	......	......	......	......	......	......	......	......	......	......	+ 16·01	¼	......	......
4143·928	......	......	......	......	......	......	......	......	......	......	− 24·61	¼	− 16·12	¼
3933·825	......	......	......	......	− 72·60	¼	+ 90·00	¼	......	......	+ 10·61	¼	......	......
Weighted mean	− 90·02		+151·77		− 75·27		+ 91·93		− 0·60		− 0·06		− 4·33	
V_a	− 23·89		− 23·89		− 25·07		− 25·07		− 26·18		− 26·40		− 26·77	
V_d	+ 0·04		+ 0·04		+ 0·04		+ 0·04		− 0·23		− 0·11		− 0·27	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	−114·1		+127·6		−100·6		+ 66·6		− 27·3		− 26·8		− 31·7	

MEASURES OF BOSS 1275—*Continued*

λ	8056		8089 p.		8089 s.		8102		8106		8113 p.		8113 s.	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	− 39·40	¼	...	...	...	...	+ 47·88	¼	...	...	...	...	− 95·15	¼
4481·400	− 11·31	½	− 93·50	¼	+138·90	½	+ 25·91	¼	+ 64·43	¼	...	...	− 66·80	¼
4383·720	...	...	...	...	...	...	+ 4·48	¼	...	...	...	...	...	...
4340·634	...	...	− 90·98	¼	+ 66·45	¼	+ 5·88	½	+ 15·58	¼	+ 64·16	¼	− 95·92	¼
3933·825	...	...	−105·70	¼	+ 40·68	¼	+ 21·09	¼	+ 46·09	¼	+ 87·98	¼	−112·20	¼
Weighted mean	− 20·34		− 96·73		+ 82·01		+ 19·58		+ 42·03		+ 76·07		− 92·52	
V_a	− 27·11		− 29·44		− 29·44		− 29·75		− 29·75		− 29·66		− 29·66	
V_d	− 0·10		− 0·11		− 0·11		− 0·07		− 0·09		− 0·23		− 0·23	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 47·8		−126·5		+ 52·2		− 10·5		+ 11·9		+ 45·9		−122·7	

MEASURES OF BOSS 1275—*Continued*

λ	8117 p.		8117 s.		8130 p.		8130 s.		8325		8329 p.		8329 s.	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481·400	+135·20	¼	− 76·41	¼	−105·30	¼	+181·40	¼	− 48·58	¼	+ 36·32	½	−146·80	¼
4383·720	....	....	....	....	....	....	....	....	− 55·19	¼	....	....	....	....
4340·634	+107·40	¼	− 49·68	¼	− 42·40	¼	+213·50	¼	....	....	+ 71·03	¼	−114·80	¼
4233·328	+144·80	¼	− 66·32	¼	....	....	....	....	....	....	....	....	....	....
4198·494	....	....	....	....	....	....	....	....	....	....	+ 54·30	¼	....	....
4045·975	+120·60	¼	−108·90	¼	....	....	....	....	....	....	....	....	....	....
3933·825	+130·00	¼	− 90·46	¼	− 47·76	¼	+137·30	¼	....	....	....	....	....	....
Weighted mean	+127·60		− 78·35		− 65·15		+177·40		− 51·88		+ 49·49		− 80·80	
V_a	− 29·44		− 29·44		− 28·09		− 28·09		+ 24·89		+ 21·77		+ 21·77	
V_d	− 0·14		− 0·14		− 0·19		− 0·19		− 0·04		− 0·15		− 0·15	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 97·7		−108·2		− 93·7		+148·8		− 27·3		+ 70·8		− 58·5	

MEASURES OF BOSS 1275—*Continued*

λ	8333 p.		8333 s.		8341 p.		8341 s.		8372 p.		8372 s.		8376	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	−133·40	¼	+ 61·64	¼	−105·20	¼	+ 49·60	¼	−122·30	¼	....	....	− 38·43	¼
4481·400	−143·80	¼	+ 61·71	¼	....	....	+ 69·15	½	−121·50	½	+133·80	¼	− 61·32	¼
4383·720	....	....	....	....	....	....	....	....	−137·60	¼	....	....	....	....
4340·634	− 89·72	¼	+ 80·00	¼	....	....	+ 69·21	¼	....	....	....	....	....	....
4233·328	....	....	....	....	....	....	....	....	− 80·75	¼	+111·30	¼	....	....
Weighted mean	−122·31		+ 67·78		−105·20		+ 64·28		−116·73		+122·55		− 49·87	
V_a	+ 18·00		+ 18·00		+ 16·77		+ 16·77		+ 4·95		+ 4·95		+ 2·81	
V_d	− 0·15		− 0·15		− 0·16		− 0·16		+ 0·27		+ 0·27		± 0·00	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	−104·7		+ 85·3		− 88·9		+ 81·6		−111·8		+127·5		− 47·3	

MEASURES OF BOSS 1275—*Continued*

λ	8381 p.		8381 s.		8407		8417		8433 p.		8433 s.		8456 p.	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	+ 62·56	¼	− 97·38	¼	− 49·30	½	+ 0·65	½	....		....		−110·80	¼
4481·400	+ 97·24	¼	− 82·21	¼	− 14·65	¼	+ 3·38	½	− 42·70	¼	+101·70	¼	−119·80	¼
4383·720	....		....		....		− 13·32	¼	....		....		− 67·90	¼
4340·634	....		− 43·00	½	....		+ 25·79	¼	....		....		....	
4233·328	+ 79·64	¼	− 88·80	¼	....		....		....		....		....	
3933·825	+ 61·42	¼	....		....		....		....		....		....	
Weighted mean	+ 75·21		− 70·88		− 37·75		+ 3·42		− 42·70		+101·70		− 99·50	
V_a	+ 0·22		+ 0·22		− 11·55		− 12·53		− 21·81		− 21·81		− 28·36	
V_d	+ 0·04		+ 0·04		− 0·01		− 0·07		− 0·04		− 0·04		− 0·14	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 75·2		− 70·8		− 49·6		− 9·5		− 64·8		+ 79·6		−128·3	

MEASURES OF BOSS 1275—*Concluded*

λ	8456 s.		8464		8468 p.		8490 p.		8490 s.		8496			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	+149·10	¼	− 16·53	¼	+157·30	¼	+151·70	¼	− 77·90	¼	......	......	......	......
4481·400	+102·40	¼	+ 22·02	¼	+146·70	¼	+126·90	¼	−117·81	¼	− 7·61	¼	......	......
4340·634	......	......	+ 16·18	¼	......	......	......	......	......	......	......	......	......	......
4271·760	+122·60	¼	......	......	......	......	......	......	......	......	......	......	......	......
Weighted mean	+119·12		+ 7·22		+152·00		+139·30		− 97·85		− 7·61		......	
V_a	− 28·36		− 29·50		− 29·76		− 27·19		− 27·19		− 26·05		......	
V_d	− 0·14		− 0·22		− 0·23		− 0·22		− 0·22		− 0·28		......	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		......	
Radial Velocity	+ 90·3		− 22·8		+121·7		+111·6		−125·5		− 34·2		......	

The forty plates were grouped so that, including the common points where the spectra were superposed, there were eight normal places for each curve. At first each component was treated separately. Preliminary elements were chosen for each and a least-squares solution carried through in each case. The resulting elements were as follows:—

$$P = 27 \cdot 43 \text{ days}$$
$$e_1 = \cdot 334$$
$$e_2 = \cdot 173$$
$$\omega_1 = 36° \cdot 62$$
$$\omega_2 = 219° \cdot 45$$
$$\gamma_1 = -27 \cdot 03 \text{ km.}$$
$$\gamma_2 = -2 \cdot 01 \text{ km.}$$
$$T_1 = 2{,}421{,}142 \cdot 5 \text{ J.D.}$$
$$T_2 = 2{,}421{,}142 \cdot 7 \text{ J.D.}$$
$$K_1 = 122 \cdot 4 \text{ km.}$$
$$K_2 = 117 \cdot 6 \text{ km.}$$

It will be seen that the greatest differences occur in the values of e and γ, and that any mean value chosen for both will necessarily greatly increase the residuals in the two cases.

The residuals from the separate treatment are given below, and can be compared with those from the elements obtained by combining the two.

Number	R_1	R_2
1	+ 8·0	− 0·9
2	− 7·9	+ 3·1
3	+ 8·2	− 10·4
4	− 4·0	+ 7·1
5	+ 1·9	− 13·7
6	− 2·2	+ 8·0
7	+ 6·9	+ 2·1
8	− 2·4	+ 0·2

The two sets of elements were then combined and the mean values of e, ω, γ, and T taken as preliminary values for the two curves, the values of K_1 and K_2 being accepted as preliminary values for them. Two least-squares solutions were found to be necessary in order to obtain the closest approximation. These resulted as follows:—

$$P = 27 \cdot 43 \text{ days}$$
$$\gamma = -14 \cdot 17 \text{ km.}$$
$$K_1 = 116 \cdot 91 \text{ km.}$$
$$K_2 = 116 \cdot 12 \text{ km.}$$
$$e = \cdot 247$$

$$\omega_1 = 29°\cdot 80$$
$$\omega_2 = 209°\cdot 80$$
$$T = 2{,}421{,}142\cdot 00 \text{ J.D.}$$
$$a_1 \sin i = 42{,}730{,}000 \text{ km.}$$
$$a_2 \sin i = 42{,}440{,}000 \text{ km.}$$
$$\frac{m_1 \sin^3 i}{(m_1 + m)^2} = 4\cdot 0 \odot$$

The normal places and their residuals are now:—

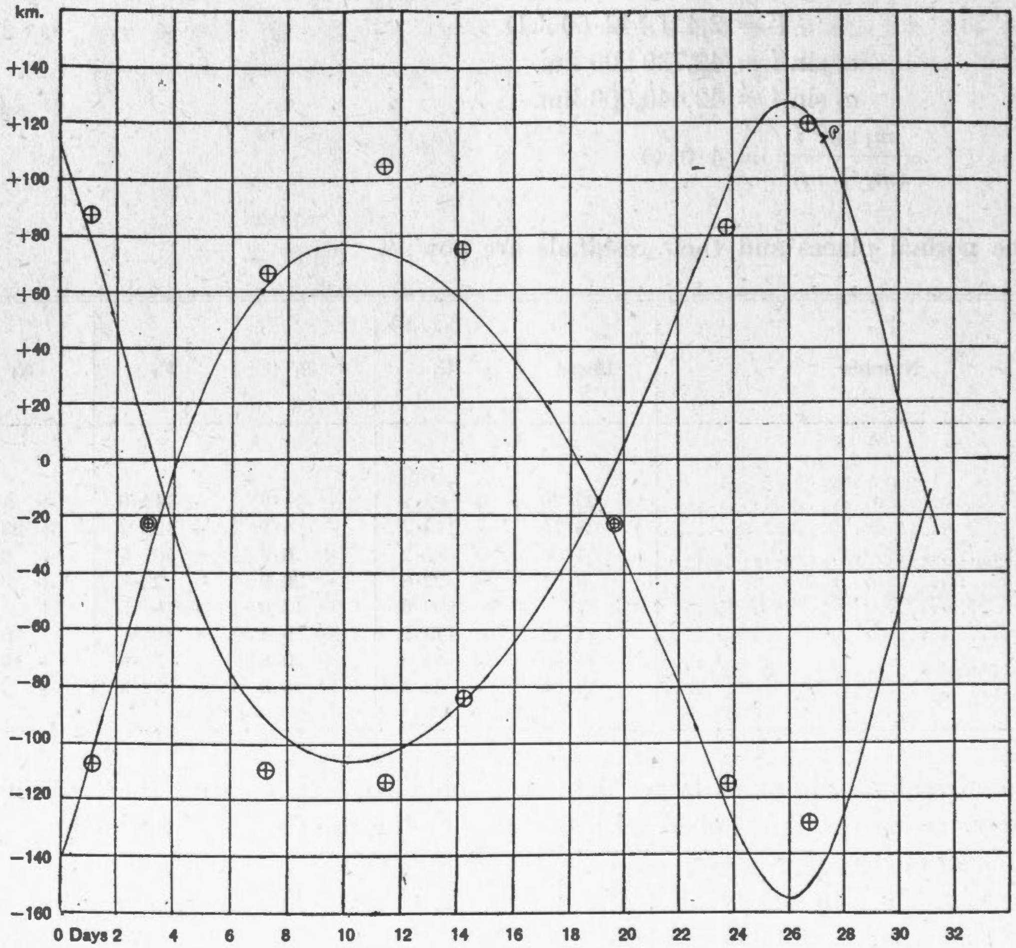
Number	Phase	V_1	R_1	V_2	R_2
1	23·76	+ 83·2	− 11·9	− 114·6	+ 8·1
2	26·76	+ 119·7	− 4·1	− 128·2	+ 23·0
3	1·06	+ 87·2	+ 6·6	− 107·5	+ 0·8
4	3·06	− 22·8	− 26·9	− 22·8	+ 9·6
5	7·26	− 109·0	− 17·0	+ 66·6	+ 3·5
6	11·46	− 113·2	− 9·4	+ 105·3	+ 30·4
7	14·26	− 84·8	+ 0·8	+ 75·9	+ 19·1
8	19·66	− 22·3	− 18·3	− 22·3	+ 2·0

These residuals are much larger than those obtained from treating the components separately. However, it is not at all probable that the stars are separate systems, but are two stars of the same system and must therefore have a common γ, e, ω and T. The lines measured are in nearly all plates poorly defined and few in number, and it is possible that a larger number of plates might have been more satisfactory.

The Mount Wilson plates from which the binary character of the star was discovered, do not give velocities which fit the curve well. However, the observations obtained here indicate that this period—27·43 days—is the correct one, and the elements found are probably a fairly close approximation to the true ones.

On the curve, the double circles are those normal places common to the two components. The values of K_1 and K_2 are practically the same, and the stars are hence about equal in mass. The lines where separated also show that there is little difference in brightness.

Dominion Observatory
Ottawa
August, 1918.



Radial Velocity Curve of Boss 1275

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 13

ORBITS OF THE SPECTROSCOPIC COMPONENTS OF BOSS 5173

BY W. E. HARPER, M.A.

This star ($\alpha = 20^h\ 06^m$, $\delta = +26°\ 37'$, magnitude 5.46, type A) was announced a spectroscopic binary by Adams in *Publications of the Astronomical Society of the Pacific*, June, 1915. He stated that the hydrogen lines showed great variations in width and intensity due probably to the presence of two spectra, there being a relative displacement of the lines of 150 km. on the first plate. On our taking up the determination of the star's orbit, Professor Adams kindly furnished the measures of three plates which are given below.

The star has been one over which the writer has expended a great deal of time, due in part, and possibly wholly, to the uncertainty of the measures. The period and general form of the velocity curves were readily obtained in the autumn of 1916, but when it came to a determination of the elements there appeared to be a difficulty. In these cases where both spectra are recorded, two curves are obtained for which the period, eccentricity, velocity of the system, and periastron passage must be identical and the longitudes of periastron must differ by 180 degrees. With the exception of the velocity of the system all the elements agreed, but in the case of this element there was a difference of some 10 or 15 km. as derived from the two curves. Of course a kind of agreement could be forced when a common value for the γ-velocity was adopted, but it was so very much inferior to the agreement when distinct values were adopted that it was felt that there was something wrong. Several least-squares solutions were put through, but the discrepancy persisted, and it was felt that more observations should be secured. In all, some 75 plates have been secured, but on about a dozen the lines are so hopelessly bad that the plates were discarded, and only 62 have been used in the final determination. The later observations minimize to some extent the discrepancy, but cannot be said to remove it entirely. However, when one reviews the plates and sees what ill-defined lines the velocities are based upon and, further, considers that for about half the period the lines are partially superposed, making measurement impossible, it would appear that the best of agreement cannot be hoped for. Consequently, since a system with different values for γ for the two components would be physically impossible, it seems better to go on the assumption of a common velocity and derive the best elements possible, even though better agreement can be secured when different values for each are used.

LINES USED IN BOSS 5173

Line	n	Residual		Correction to λ	Wave-Lengths Used
		Numerical	Algebraic		
4584·018	19	14·8	+ 6·3	—·096	4583·922
4572·190	9	10·2	+ 3·9	—·060	4572·130
4549·743	64	10·4	— 0·7		4549·743
4534·158	15	9·4	+ 2·4	—·036	4534·122
4522·908	4	14·3	— 9·1	+·137	4522·731
4520·397	8	7·9	— 0·8	....	4520·397
4501·417	2	12·5	— 4·5	+·068	4501·485
4481·477	83	11·3	+ 4·0	—·060	4481·417
4415·345	11	9·6	+ 6·9	—·102	4415·243
4404·861	5	7·5	— 3·5	+·051	4404·912
4395·155	5	8·7	— 6·2	+·091	4395·246
4351·977	22	13·3	— 5·0	+·073	4352·050
4340·645	48	10·7	+ 0·1	....	4340·645
4325·698	41	12·8	— 4·6	+·066	4325·764
4315·178	5	8·3	+ 3·1	—·045	4315·133
4307·974	39	10·5	— 0·5	....	4307·974
4300·000	9	13·2	+11·0	—·158	4299·842
4294·359	6	6·2	— 2·6	+·037	4294·396
4271·675	44	9·0	+ 2·4	—·034	4271·641
4260·537	7	9·1	— 0·8	....	4260·537
4250·586	6	9·7	+ 3·8	—·054	4250·532
4236·000	19	14·1	— 9·4	+·133	4236·133
4233·425	36	10·4	+ 0·1	....	4233·425
4227·107	25	13·4	+ 0·6	....	4227·107
4215·733	18	10·2	+ 6·0	—·084	4215·649
4202·366	5	7·0	+ 1·9	....	4202·366
4198·677	10	8·9	+ 7·1	—·100	4198·577
4143·839	33	10·4	+ 1·0	....	4143·839
4101·898	9	15·8	+ 8·3	—·114	4101·784
4077·862	30	10·0	+ 1·2	....	4077·862
4071·865	16	16·5	— 8·8	+·120	4071·985
4063·730	24	9·6	— 4·0	+·054	4063·784
4045·940	56	11·0	— 5·1	+·069	4046·009
4005·414	14	12·6	— 4·6	+·062	4005·476
3933·825	7	9·4	— 2·2	+·031	3933·856

OBSERVATIONS OF BOSS 5173

Plate	Date	Julian Day	Phase	Component I Vel.	Component I Wt.	Component I O–C	Component II Vel.	Component II Wt.	Component II O–C
	1914								
Mt. Wilson	June 12	2,420,296·973	1·661	−85·0		0·0	+ 64·0		− 2·0
"	July 12	326·827	3·567	−37·0					
"	Aug. 4	349·791	7·899	−40·0					
	1915								
7194	Sept. 2	743·624	1·144	−86·9	3	− 6·9	+ 65·0	2	+ 5·0
7308	" 30	771·502	1·074	−87·6	3	− 9·9	+ 60·5	2	+ 3·2
7327	Oct. 10	781·531	1·787	−91·9	4	− 0·1	+ 63·1	2	−10·2
7347	" 16	787·486	7·742	+38·9	3	− 7·3	− 84·8	3	− 5·8
7379	Nov. 6	808·510	0·818	−66·2	2	+ 3·8	+ 53·1	1	+ 5·1
7409	" 16	818·443	1·435	−93·5	2	− 6·9	+ 42·8	2	−15·2
7425	" 24	826·464	0·140	−21·5					
7435	Dec. 1	833·519	7·195	+52·3	5	− 8·3	−103·6	2	− 8·6
	1916								
7472	Jan. 6	869·446	5·858	+43·2	2	−10·9	− 83·4	2	+ 3·0
7479	" 13	876·452	3·548	−23·7					
7640	May 7	991·838	7·142	+62·3	5	+ 0·3	− 78·9	2	+17·1
7648	" 9	993·850	9·154	− 8·9	7				
7651	" 13	997·861	3·849	−16·8					
7667	" 24	2,421,008·850	5·522	+40·3	1	− 2·0	− 76·5	1	− 1·5
7670	" 25	009·847	6·519	+74·2	4	+ 9·2	− 88·8	3	+10·2
7676	" 28	012·831	0·187	−15·7					
7681	" 31	015·826	3·182	−70·5	3	− 3·5	+ 62·3		
7684	June 1	016·740	4·096	− 8·0	6				
7693	" 6	021·812	9·168	−17·3	10				
7697	" 13	028·817	6·857	+61·0	8	− 4·0	−111·4	4	−12·4
7698	" 17	032·498	1·222	−80·3	1	+ 1·0	+ 79·6	2	+17·0
7702	" 23	038·635	7·359	+64·8	5	+ 7·0	− 87·0	2	+ 4·0
7711	" 29	044·779	4·187	− 8·4	9				
7721	July 6	051·659	1·751	−85·8	6	+ 5·6	+ 68·3	3	− 5·0
7722	" 6	051·737	1·829	−89·2	6	+ 2·4	+ 78·2	3	+ 4·2
7727	" 11	056·711	6·803	+65·6	4	0·0	− 91·0	4	+ 8·0
7744	" 19	064·683	5·459	+46·7	7	+ 6·7	− 84·2	5	−11·2
7747	" 20	065·589	6·365	+64·8	4	+ 1·4	−101·0	3	− 3·0
7750	" 21	066·829	7·605	+61·0	4	+10·0	− 79·8	3	+ 4·2
7756	" 24	069·676	1·136	−76·1	7	+ 3·0	+ 48·2	5	−11·8
7760	" 25	070·736	2·196	−87·7	7	+ 3·3	+ 78·2	5	+ 5·2
7761	" 25	070·817	2·277	−85·1	5	+ 4·9	+ 57·2	3	−12·8
7770	Aug. 1	077·832	9·292	−18·7	7				
7772	" 2	078·683	0·827	−61·3	6	+ 8·7	+ 56·7	5	+ 7·7
7777	" 13	089·700	2·528	−92·4	4	− 6·4	+ 53·9	4	−13·7
7778	" 13	089·799	2·627	−90·8	4	− 6·8	+ 70·6	3	+ 4·6
7793	" 18	094·666	7·494	+43·9	4	−10·1	− 85·4	4	+ 2·6
7794	" 21	097·622	1·134	−73·9	3	+ 6·1	+ 59·2	3	− 1·2
7801	Sept. 6	113·607	7·803	+63·5	3	+ 1·5	− 85·4	3	− 8·4
7804	" 9	116·692	1·572	−97·7	4	− 7·7	+ 74·4	2	+ 3·4
7822	" 30	137·508	3·756	−22·2					
7836	Oct. 2	139·591	5·839	+59·4	4	+ 6·4	− 90·5	3	− 4·5
7847	" 4	141·507	7·755	+44·9	3	+ 1·0	− 77·9	3	0·0
7876	" 12	149·558	6·490	+54·7	3	−10·0	−112·5	4	−13·5
7888	Nov. 4	172·460	1·444	+67·8	2	− 4·4	− 82·6	2	+ 1·0

OBSERVATIONS OF BOSS 5173—*Concluded*

Plate	Date	Julian Day	Phase	Component I			Component II		
				Vel.	Wt.	O–C	Vel.	Wt.	O–C
	1916								
7915	Nov. 22	2,421,190·462	0·814	−27·9					
7919	" 25	193·449	3·801	−28·0					
7940	Dec. 16	214·445	6·165	+60·7	4	− 0·3	− 94·0	2	+ 1·0
7952	" 19	217·463	9·183	− 3·7	6				
	1917								
8219	July 5	415·807	2·575	−78·4	4	+ 6·6	+ 54·6	3	−13·4
8233	" 22	432·751	0·887	−68·7	4	+ 3·5	+ 86·2	2	+35·7
8245	" 27	437·688	5·824	+72·1	2	+19·1	− 95·7	2	− 9·7
8260	Aug. 6	447·681	6·501	+65·6	2	+ 0·6	−102·0	3	− 3·0
8264	" 10	451·644	1·148	−88·3	2	− 8·3	+ 63·1	1	+ 3·2
8280	Sept. 3	475·682	6·554	+70·5	2	+ 5·5	−110·4	1	−11·0
8281	" 4	476·575	7·447	+47·7	1				
8291	" 8	480·665	2·221	−122·1	2	−32·0	+ 45·6	1	−27·4
8295	" 11	483·705	5·261	+57·9					
8306	" 24	496·623	8·863	−24·6					
8311	" 26	498·654	1·578	−94·8	2	− 5·8	+ 67·6	2	− 3·4
8321	Oct. 15	517·563	1·855	−96·3	4	− 4·3	+ 96·0		
8344	Nov. 10	2,421,543·492	9·152	−12·4	3				

MEASURES OF BOSS 5173

λ	7194		7194		7308		7308		7327		7327		7347	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481					−88·5	½	+101·4	¼	−58·1	¼				
4340	−93·2	¼	+61·2	¼	68·2	½	77·6	¼					+51·3	½
4325													59·6	½
4308									58·3	½			53·1	¾
4271									64·6	¼				
4236			77·3	½										
4233	83·4	¼	+79·8	½	63·1	¼			96·9	¼	+71·3	½		
4198	85·7	½							85·5	½				
4101													50·6	¼
4077					55·0	½	+66·4	½					73·6	¼
4063	64·6	½			81·7	¼			72·3	¼				
4045	−60·3	¼			−64·0	¼			80·1	¼			+72·0	½
4005									60·8	¼	93·8	¼		
3933									−77·8	¼	+94·0	¼		
Weighted mean	−76·80		+75·04		−70·22		+77·90		−72·55		+82·50		+58·98	
V_a	− 9·74		− 9·74		−17·15		−17·15		−19·06		−19·06		−19·80	
V_d	− 0·04		− 0·04		+ 0·04		+ 0·04		− 0·05		− 0·05		0·00	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	−86·9		+65·0		−87·6		+60·5		−91·9		+63·1		+38·9	

MEASURES OF BOSS 5173—*Continued*

λ	7347		7379		7379		7409		7409		7425		7435	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584							−65·6	¼	+59·7	¼				
4549			−38·2	½							+ 6·5	½		
4534			45·6	½			60·3	¼					+70·6	½
4501											−12·9	½		
4481			51·5	¼	+77·1	¼	99·0	½			+ 8·3	½	71·5	½
4340	−96·6	¼	24·9	¼			79·5	¼	53·5	¼	+ 1·8	½		
4325	51·5	¼	33·3	¼			68·3	¼			− 0·9	½	93·1	¼
4308	46·2	¼					58·2	½	76·5	¼	+12·6	¾	66·0	½
4271			49·9	¼									43·3	¼
4260													90·5	¼
4236											−13·1	¾	69·2	¼
4233											− 0·5	¾		
4202													77·8	¼
4198			34·5	¼			66·4	¼	51·5	½	− 3·4	½	82·6	¼
4143									+90·1	¼			56·0	¼
4101	77·4	¼	−65·4	½	+72·0	¼								
4063											−19·3	¼		
4045	−52·1	¼					−70·0	¼			− 4·4	½	+72·7	¾
Weighted mean	−64·76		−44·76		+74·55		−72·48		+63·73		− 1·20		+71·65	
V_a	−19·80		−21·01		−21·01		−20·62		−20·62		−19·84		−18·83	
V_d	0·00		− 0·14		− 0·14		− 0·08		− 0·08		− 0·14		− 0·20	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	−84·8		−66·2		+53·1		−93·5		+42·8		−21·5		+52·3	

MEASURES OF BOSS 5173—*Continued*

λ	7435		7472		7472		7479		7640		7640		7648	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584							− 5·0	¼						
4572									+45·4	¼	−117·6	¼		
4549							3·9	¼	41·3	½	95·7	¼	−27·5	¾
4534	−93·4	¼												
4520			+52·3	¾										
4481	94·3	¼	52·1	¼			12·2	¼	36·8	¾	83·7	¼	23·7	¾
4352							24·9	½					40·3	½
4340			50·0	¼					20·0	½			36·8	½
4325	62·6	½			−76·9	¼			51·9	½			17·2	¼
4308					65·2	¼							19·7	½
4294									54·3	¼				
4271													29·4	¾
4250			39·0	¼	−77·8	¼								
4236			+75·1	¼										
4233							−19·0	¾					19·4	½
4227									46·5	¼	111·6	¼	22·8	¼
4215													27·2	½
4143													46·0	¾
4101											−88·1	¼		
4077									42·3	½				
4063									50·7	¼			44·0	½
4045	−92·5	¾							+47·2	½			29·3	½
4005													−11·6	½
Weighted mean	−84·34		+53·31		−73·30		−15·95		+41·91		−99·34		−29·21	
V_a	−18·83		− 9·61		− 9·61		− 7·23		+20·57		+20·57		+20·47	
V_d	− 0·20		− 0·24		− 0·24		− 0·24		+ 0·14		+ 0·14		+ 0·11	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	−103·6		+43·2		−83·4		−23·7		+62·3		−78·9		− 8·9	

MEASURES OF BOSS 5173—*Continued*

λ	7651		7667		7667		7670		7670		7676		7681	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584											− 4·7	½	−50·2	¼
4572	−57·4	½												
4549	48·8	½	+ 3·0	¼			+79·4	½	−124·0	¼	50·7	½	87·8	¼
4534											41·7	½		
4481	34·2	½	− 0·3	¼	−98·9	¼	38·6	½	97·8	¼	33·4	½		
4352											50·3	½	105·3	¼
4340	25·1	½	+39·5	¼							39·5	½		
4308	35·1	½					34·0	¼	100·5	¼				
4294	36·2	½												
4271			+41·5	¼							21·4	½		
4236							85·3	¼						
4233	30·5	½									53·7	½		
4227	20·0	½											93·7	¼
4215	40·8	½					51·1	½						
4202			+ 2·1	¼										
4198			+30·3	¼										
4143			+27·9	¼							43·8	½	91·0	¼
4101											43·0	½		
4077	73·9	¼					39·9	½	−108·3	¼			88·9	½
4071											23·1	½		
4063	51·8	¼									29·8	½		
4045	−15·1	½	+24·0	½	−92·1	¼	62·2	½			13·6	½	−95·6	½
4005							65·4	½						
3933							+37·8	¼			−26·8	¼		
Weighted mean	−36·91		+21·33		−95·50		+55·33		−107·65		−34·09		−88·53	
V_a	+20·28		+19·20		+19·20		+19·06		+19·06		+18·65		+18·24	
V_d	+ 0·09		+ 0·04		+ 0·04		+ 0·04		+ 0·04		+ 0·06		+ 0·06	
Curv.	− 0·28		− 0·28		− 0·28		+ 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	−16·8		+40·3		−76·5		+74·2		−88·8		−15·7		−70·5	

MEASURES OF BOSS 5173—*Continued*

λ	7681		7684		7693		7697		7697		7698		7698	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584			−33·8	½	−37·3	¼	+20·3	¼						
4572					23·7	¼								
4549			34·0	½	27·8	¾					−94·4	¼	+80·4	½
4534			30·7	½	29·6	¼								
4522					27·9	¼								
4520					31·6	¼	36·8	¼						
4481			12·6	¾	20·7	¾	42·5	½	−120·1	¼	104·6	¼	77·0	¼
4415							35·6	¾						
4404					41·9	¼								
4395					48·0	¼								
4352					46·0	¼	30·8	¼	148·7	½				
4340					29·4	½	44·6	½	149·2	¼				
4325					40·6	¼	43·6	½						
4315					26·3	¼								
4308					40·0	½	27·6	¼						
4300					43·4	¼								
4290					27·7	¼								
4271			10·1	½	17·6	¼	53·9	½	107·6	¼	86·0	¼	52·0	½
4236			14·3	½	24·6	¼	40·8	½						
4233			30·1	½	27·9	¼					−94·3	¼		
4227	+70·1	¼			19·3	½							+49·0	¼
4215			28·9	½	58·1	½	64·4	½	132·0	¼				
4143	49·8	¼	46·2	½	35·2	¾	57·7	½	129·4	¼				
4101							71·3	½						
4077	26·8	¼	18·8	½	56·6	¼	28·6	¼	110·7	¼				
4071							19·6	½						
4063			24·2	½	35·9	¼	45·3	½						
4045	+30·6	¼	36·1	½	41·1	¾	55·9	½	−115·7	¼				
4005			−22·2	¼	42·6	¼	+63·7	½						
3933					−40·5	¼								
Weighted mean	+44·32		−25·91		−34·14		+45·54		−126·68		−94·82		+65·07	
V_a	+18·24		+18·02		+17·10		+15·62		+ 15·62		+14·65		+14·65	
V_d	+ 0·06		+ 0·18		+ 0·05		− 0·08		− 0·08		+ 0·16		+ 0·16	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+62·3		− 8·0		−17·3		+61·0		−111·4		−80·3		+79·6	

MEASURES OF BOSS 5173—*Continued*

λ	7702		7702		7711		7721		7721		7722		7722	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584					−30·1	½								
4549	+42·3	½	−107·3	¼	33·0	½	−99·5	½						
4481	30·8	¼	107·2	¼	13·4	¾	105·7	½	+54·8	¼	−103·0	½		
4404					24·5	½								
4395					10·5	¼								
4352							76·3	½	51·9	¼				
4340	73·0	½	103·8	¼	14·4	¾	77·6	½	56·6	¼	113·0	¼	+61·0	¼
4325					25·0	½	106·9	¾	64·5	½				
4315							85·6	½	63·7	¼				
4308	53·6	¼									115·0	¾	76·5	¾
4300					14·4	½								
4271	51·5	¼	−82·3	¼	10·4	½					102·9	¾		
4260							95·8	½						
4250	42·9	¼			7·5	½								
4236	42·0	¼												
4233					22·1	½	112·3	½			71·6	½	64·7	½
4215	46·8	¼			18·2	½					88·6	½	80·3	¼
4202	59·5	¼												
4143	71·7	¼			32·7	½	94·3	¼			101·7	¾	77·0	¼
4101					7·9	½								
4077					20·4	½	89·7	¼			90·6	½	+56·5	½
4071	52·3	¾							+56·9	¼				
4063					24·0	½								
4045	+40·6	¼			25·6	¾	81·6	½			−94·3	½		
4005					−15·0	½	−107·3	½						
Weighted mean	+ 51·65		−100·15		− 19·56		− 95·08		+ 58·97		− 98·40		+ 68·96	
V_a	+ 13·20		+ 13·20		+ 11·45		+ 9·45		+ 9·45		+ 9·45		+ 9·45	
V_d	+ 0·24		+ 0·24		0·00		+ 0·14		+ 0·14		+ 0·04		+ 0·04	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 64·8		− 87·0		− 8·4		− 85·8		+ 68·3		− 89·2		+ 78·2	

MEASURES OF BOSS 5173—*Continued*

λ	7727		7727		7744		7744		7747		7747		7750	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584	+64·6	½	−77·5	½										
4549	52·6	½	95·1	¼					+31·6	¼	−87·9	¼		
4534									50·4	¼	116·0	¼		
4481	83·6	½	93·3	¼	+29·2	¼	−92·0	¼	97·3	¼	91·4	¼	+71·3	½
4415					39·3	¼	90·3	¼						
4352					52·0	¼			49·5	¼	145·5	¼		
4340					35·8	½	91·6	¼					34·0	¼
4325	43·2	¼	114·6	¼	41·9	½	80·6	¼						
4308	48·2	½							50·2	¼			50·5	½
4300					37·3	¼	100·2	¼						
4294	50·6	½			43·1	½							62·1	½
4271	64·9	½	103·6	¼	30·0	½	91·2	¼	57·1	½	105·8	½	47·9	½
4260									50·6	¼				
4233									55·5	¼	−89·4	¼	74·1	½
4227					30·0	½	88·2	½	84·6	¼				
4215					61·5	¼	93·9	¼						
4143					56·6	¾			78·0	¼				
4077					29·6	¼	84·0	¼						
4071									64·0	¼				
4063					48·1	¾			68·4	¼				
4045	+40·1	¼	−129·1	¼	+39·1	¾	−85·1	½	+45·9	¼				
4005													24·9	¼
3933													+69·6	¼
Weighted mean	+ 58·00		− 98·68		+ 41·66		− 89·20		+ 60·00		−105·80		+ 56·90	
V_a	+ 7·87		+ 7·87		+ 5·26		+ 5·26		+ 4·90		+ 4·90		+ 4·53	
V_d	+ 0·06		+ 0·06		+ 0·07		+ 0·07		+ 0·18		+ 0·18		− 0·17	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 65·6		− 91·0		+ 46·7		− 84·2		+ 64·8		−101·0		+ 61·0	

MEASURES OF BOSS 5173—*Continued*

λ	7750		7756		7756		7760		7760		7761		7761	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584							−96·1	½			−82·6	¼		
4549			−60·6	½			84·2	½	+83·4	½				
4534							88·2	¼	98·6	¼				
4522													+35·4	½
4520					+64·5	½			66·0	½			45·9	¼
4481			86·0	½			100·4	¾	61·8	¼	89·1	½		
4415									79·7	½				
4395			85·0	½			81·3	½						
4352					49·4	½								
4340			84·0	½							65·7	¼		
4325			82·2	½	19·0	½					120·3	¼	77·8	¼
4315			95·5	¼										
4308					62·5	¼	87·0	½			99·9	½	77·4	¼
4294													45·6	½
4271	−106·3	½	70·6	½	37·6	½	84·9	¼	77·6	¼				
4236					36·0	¼								
4233	76·4	¼	74·0	½										
4227			87·6	¼	74·6	¼	120·9	¼	62·1	¼	72·0	¼		
4215							93·5	½	69·6	¼				
4143			91·6	¼	83·0	¼					89·6	¼	75·5	¼
4077							86·0	¼	+75·8	¼				
4071	−65·4	½	75·6	¼									+23·5	¼
4063			85·4	¾	29·7	½								
4045			−71·8	¾	+31·1	½	74·2	¾			78·2	½		
4005							−103·0	½			−90·1	¼		
Weighted mean	− 83·92		− 79·47		+ 44·88		− 90·56		+ 75·27		− 87·87		+ 54·44	
V_a	+ 4·53		+ 3·56		+ 3·56		+ 3·24		+ 3·24		+ 3·24		+ 3·24	
V_d	− 0·17		+ 0·06		+ 0·06		− 0·06		− 0·06		− 0·18		− 0·18	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 79·8		− 76·1		+ 48·2		− 87·7		+ 78·2		− 85·1		+ 57·2	

MEASURES OF BOSS 5173—*Continued*

λ	7770		7772		7772		7777		7777		7778		7778	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584	−31·0	½												
4572	36·1	¼												
4549	21·8	½	−56·4	¼			−123·4	¼	+70·1	¼	−80·9	½		
4534	27·5	¼												
4481	26·2	¾	53·9	½	+33·8	¼	98·2	½	84·0	¼	94·2	½	+61·1	¼
4415	7·7	¼					98·2	¼					50·4	¼
4404							73·3	½	49·3	¼				
4352							58·6	¼						
4340	27·6	¼	66·7	¼	66·4	¼					51·6	¼	91·4	½
4325	2·6	½	90·4	¼	19·2	¼	101·5	¼	54·2	¼				
4308	35·6	¼	61·5	¼	53·8	¼	64·1	¼	57·6	¼	73·1	¼	70·3	¼
4300	3·0	½												
4271	18·6	½	68·4	¼							102·9	½		
4260											91·7	¼		
4236	60·6	¼							45·4	¼				
4233	12·5	½	39·2	¼	77·2	¼	132·1	¼	59·1	¼				
4227	27·6	½												
4198											78·9	¼		
4143					59·2	¼					89·8	¼	+82·5	¼
4077	2·4	½	−61·3	½	+86·7	¼								
4063	8·6	½												
4045	−10·0	½					−55·5	¼	+41·6	¼	−101·7	¼		
Weighted mean	− 18·95		− 61·32		+ 56·61		− 88·70		+ 57·66		− 86·87		+ 74·53	
V_a	+ 0·75		+ 0·34		+ 0·34		− 3·38		− 3·38		− 3·38		− 3·38	
V_d	− 0·22		0·00		0·00		− 0·07		− 0·07		− 0·22		− 0·22	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 18·7		− 61·3		+ 56·7		− 92·4		+ 53·9		− 90·8		+ 70·6	

MEASURES OF BOSS 5173—*Continued*

λ	7793		7793		7794		7794		7801		7801		7804	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584									+58·7	¼	−86·7	¼		
4549	+63·2	½	−63·6	¼	−62·0	¼	+77·7	¼	81·9	¼	59·8	¼	−95·7	¾
4534					40·6	¼								
4522	56·9	½	67·6	½										
4520							69·6	¼						
4481	46·1	½	90·4	½	69·1	½							87·0	¼
4415					61·6	¼	73·7	¼	75·6	¼				
4404					73·5	¼								
4395											73·4	¼		
4352													73·4	½
4340	46·8	½											75·9	¼
4325	37·4	¼					39·7	¼						
4308					82·6	¼	64·1	¼	68·9	¼				
4300	26·2	¼												
4271	60·0	¼	66·3	½					69·7	¼			93·7	½
4260	72·6	¼	86·0	¼										
4250									71·8	¼				
4236							101·0	¼						
4233	60·6	½											73·1	¼
4227	36·3	¼	119·6	¼							92·1	¼	76·5	½
4215									81·8	¼				
4143	24·5	½												
4071	67·3	¼	70·3	¼					+90·7	¼	−58·1	¼		
4063	59·2	¼	−91·2	¼	72·5	¼	64·7	¼						
4045	+31·8	¼			69·0	¼	+33·7	¼					−95·7	¼
4005					−76·1	¼								
Weighted mean	+ 49·30		− 79·98		− 67·52		+ 65·52		+ 74·89		− 74·02		− 85·14	
V_a	− 5·08		− 5·08		− 6·10		− 6·10		− 11·10		− 11·10		− 12·11	
V_d	− 0·04		− 0·04		+ 0·02		+ 0·02		− 0·04		− 0·04		− 0·16	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 43·9		− 85·4		− 73·9		+ 59·2		+ 63·5		− 85·4		− 97·7	

MEASURES OF BOSS 5173—*Continued*

λ	7804		7822		7836		7836		7847		7847		7876	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572									+81·3	½				
4549			+17·4	¼	+74·7	½			44·4	½				
4534					83·7	½	−89·5	¼						
4481			+ 5·2	½	71·8	½	30·6	¼	54·9	½	−63·0	½	+95·0	½
4415					78·7	¼								
4352	+86·6	¼							76·5	½				
4340	84·7	¼	−12·2	¾	63·1	¼					39·8	¼		
4325	96·6	¼	+14·2	½	74·4	¼			39·9	¼			81·0	½
4308													63·0	½
4300													55·3	¼
4271			− 5·6	½	80·4	½	67·4	¼					+62·4	¼
4260							81·0	¼						
4236			−14·5	½	107·9	¼								
4233			+ 8·4	½			64·4	¼			67·6	½		
4227	82·2	¼	−17·9	¼										
4215			−11·6	¼										
4198			+ 2·8	½										
4143					82·5	½	111·6	¼						
4077					66·8	¼	74·1	¼	67·2	½	50·9	¼		
4063									79·1	¼	48·3	¼		
4045	+84·5	¼	−26·3	¾	88·3	¼	−60·1	¼	+54·9	¼	−67·7	½		
4005					+65·2	½								
3933			− 0·1	½										
Weighted mean	+ 86·92		− 4·61		+ 77·53		− 72·34		+ 63·23		− 59·51		+ 74·45	
V_a	− 12·11		− 17·31		− 17·72		− 17·72		− 18·07		− 18·07		− 19·38	
V_d	− 0·16		+ 0·03		− 0·12		− 0·12		0·00		0·00		− 0·11	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 74·4		− 22·2		+ 59·4		− 90·5		+ 44·9		− 77·9		+ 54·7	

MEASURES OF BOSS 5173—*Continued*

λ	7876		7888		7888		7915		7919		7940		7940	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572									− 7·3	½				
4549	−81·3	¼			−69·6	¼	+ 4·4	¼	− 1·3	½	+63·0	¼	−107·6	¼
4501			+118·3	¼										
4481	77·5	¼					−12·1	¼	+13·8	½	77·6	¾	81·9	¾
4352									− 1·7	¼	90·4	¼	−57·1	½
4340	66·4	¼									85·2	¼		
4325	80·3	¼			38·8	½					76·2	¼		
4315	104·4	¼												
4308	105·8	¼			76·3	¼								
4300	107·5	¼							+ 0·8	¼				
4271	114·2	¼							− 7·2	½				
4236			77·7	½										
4233					−71·9	½			−31·2	½				
4143							−14·9	¼	−10·9	½				
4077											66·2	¼		
4071			+82·7	¼										
4045	−97·3	¼							−30·8	¼	+76·9	¼		
Weighted mean	− 92·74		+ 89·10		− 61·27		− 7·53		− 7·95		+ 76·76		− 77·93	
V_a	− 19·38		− 21·02		− 21·02		− 19·98		− 19·62		− 15·55		− 15·55	
V_d	− 0·11		− 0·04		− 0·04		− 0·14		− 0·14		− 0·20		− 0·20	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	−112·5		+ 67·8		− 82·6		− 27·9		− 28·0		+ 60·7		− 94·0	

MEASURES OF BOSS 5173—*Continued*

λ	7952		8219		8219		8233		8233		8245		8245	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584	+ 1·7	½												
4572	15·1	½	−77·9	¼										
4549	11·1	½	98·5	½	+55·7	¼	−70·1	¼	+74·8	¼	−92·3	¼	+57·4	¼
4534	5·5	½												
4481	20·6	½	80·1	¾	58·9	¼	68·3	½	95·3	¼	103·9	¼	53·4	¼
4352	13·9	½												
4340			85·4	¼			91·4	½			−105·1	½	+87·9	¼
4325	9·1	½												
4271	6·5	½												
4236	16·7	¼												
4227	+25·4	¼												
4215			94·7	¼										
4202			88·0	¼	42·7	¼								
4143							59·0	¼	+76·8	¼				
4101							90·3	¼						
4077							88·2	½						
4071			−95·8	¼	+23·2	¼	47·9	¼						
4063							−54·6	½						
Weighted mean	+ 11·56		− 87·88		+ 45·12		− 72·70		+ 82·30		−101·60		+ 66·23	
V_a	− 14·78		+ 9·79		+ 9·79		+ 4·30		+ 4·30		+ 6·16		+ 6·16	
V_d	− 0·22		− 0·07		− 0·07		− 0·07		− 0·07		+ 0·02		+ 0·02	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 3·7		− 78·4		+ 54·6		− 68·7		+ 86·2		− 95·7		+ 72·1	

MEASURES OF BOSS 5173—*Continued*

λ	8260		8260		8264		8264		8280		8280		8281	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549			−127·6	¼	−81·1	¼			+80·2	¼	−85·3	½	+58·5	¼
4481	+60·8	½	105·8	½	109·9	¼			62·0	½	−107·0	½		
4415					−75·9	½	+65·6	½						
4308			101·0	¼										
4271									90·2	½				
4236									+91·7	½				
4045	+78·5	¼	−64·1	¼										
Weighted mean	+ 66·70		−100·80		− 85·80		+ 65·60		+ 81·14		− 99·77		+ 58·50	
V_a	− 0·85		− 0·85		− 2·23		− 2·23		− 10·23		− 10·23		− 10·53	
V_d	− 0·02		− 0·02		+ 0·02		+ 0·02		− 0·14		− 0·14		+ 0·04	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	+ 65·6		−102·0		− 88·3		+ 63·1		+ 70·5		−110·4		+ 47·7	

MEASURES OF BOSS 5173—*Continued*

λ	8291		8291		8295		8306		8311		8311		8321	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584									−82·0	½	+ 47·3	¼		
4549	−96·2	½					+ 6·6	¼					−81·9	½
4481	−137·4	¼	+57·7	¼			−25·0	¾	76·4	½	+103·1	½	83·9	¾
4352							− 4·1	½						
4325							+ 6·2	½						
4308													47·9	¼
4271					+71·0	¾								
4236													71·0	½
4233							− 4·7	¼					76·0	½
4227							− 6·5	½						
4143													−77·8	½
4045							−12·3	½	−75·4	½				
Weighted mean	−109·93		+ 57·70		+ 71·00		− 8·18		− 77·93		+ 84·50		− 76·13	
V_a	− 11·73		− 11·73		− 12·61		− 15·97		− 16·43		− 16·43		− 19·75	
V_d	− 0·14		− 0·14		− 0·19		− 0·14		− 0·18		− 0·18		− 0·14	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	−122·1		+ 45·6		+ 57·9		− 24·6		− 94·8		+ 67·6		− 96·3	

MEASURES OF BOSS 5173—*Concluded*

λ	8321		8344											
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549			+ 8·2	½										
4481	+116·2	¾	+ 4·6	¾										
4325			+18·8	½										
4271			− 2·2	¼										
4250			+14·6	¼										
Weighted mean	+116·20		+ 8·89											
V_a	− 19·75		− 20·91											
V_d	− 0·14		− 0·14											
Curv.	− 0·28		− 0·28											
Radial Velocity	+ 96·0		− 12·4											

NORMAL PLACES OF BOSS 5173

No.	Mean Phase	Mean Velocity	Weight	Residual	
				Preliminary	Final
1	1·015	− 74·3	3	+ 5·5	+ 1·7
2	1·493	− 92·1	1	− 2·2	− 4·2
3	1·926	− 91·8	3	0·0	− 0·1
4	2·592	− 84·2	2	− 2·3	+ 0·5
5	4·151	− 8·2	1	+11·0	+13·3
6	5·653	+ 52·2	1·5	+ 7·5	+ 4·5
7	6·409	+ 65·0	2	+ 4·6	+ 1·0
8	6·989	+ 60·2	2	− 0·5	− 3·5
9	7·589	+ 53·6	2·5	+ 4·8	+ 2·9
10	9·165	− 11·3	1·5	+15·3	+11·7
11	1·019	+ 59·1	2	− 0·6	+ 2·7
12	1·450	+ 66·4	1	− 4·0	− 2·0
13	1·965	+ 71·6	1·5	− 1·4	− 2·0
14	2·504	+ 58·7	1·5	− 5·8	− 9·1
15	4·151	− 8·2	0·5	+ 0·4	− 4·5
16	5·669	− 86·7	1·5	− 5·8	− 6·3
17	6·437	−101·4	1·5	− 2·9	− 3·4
18	6·943	− 97·9	1	+ 1·0	− 0·2
19	7·634	− 83·3	2	+ 0·3	− 1·5
20	9·165	− 11·3	1	−11·1	− 9·4

Preliminary elements were obtained as in the following table.

ELEMENTS OF BOSS 5173

Element	Preliminary	Final
P	9·316 days	9·316 days
e	0·04	0·012
ω	105°	103°·15
ω_1	285°	283°·15
K	77 km.	78·49 km.
K_1	86·7 km.	86·31 km.
γ	−14·20 km.	−13·04 km.
T	J. D. 2,420,304·628	J. D. 2,420,304·628
$a \sin i$		10,054,000 km.
$a_1 \sin i$		11,055,000 km.
$m \sin^3 i$		2·27 ⊙
$m_1 \sin^3 i$		2·06 ⊙

The period was considered fixed from the early observations. Observation equations were built up in the usual way for the other elements and a solution effected. Corresponding to the normal places at the intersections of the curves an observation equation, suitably weighted, was formed for both primary and secondary. Making the substitutions,

$$x = \delta\gamma$$
$$y = \delta K$$
$$y_1 = \delta K_1$$
$$z = 100\ \delta e$$
$$u = 100\ \delta\omega$$
$$v = [1.83000]\ \delta T$$

the following observation equations resulted. Owing to the similarity of coefficients for ω and T, it was found necessary to consider T as fixed.

OBSERVATION EQUATIONS OF BOSS 5173

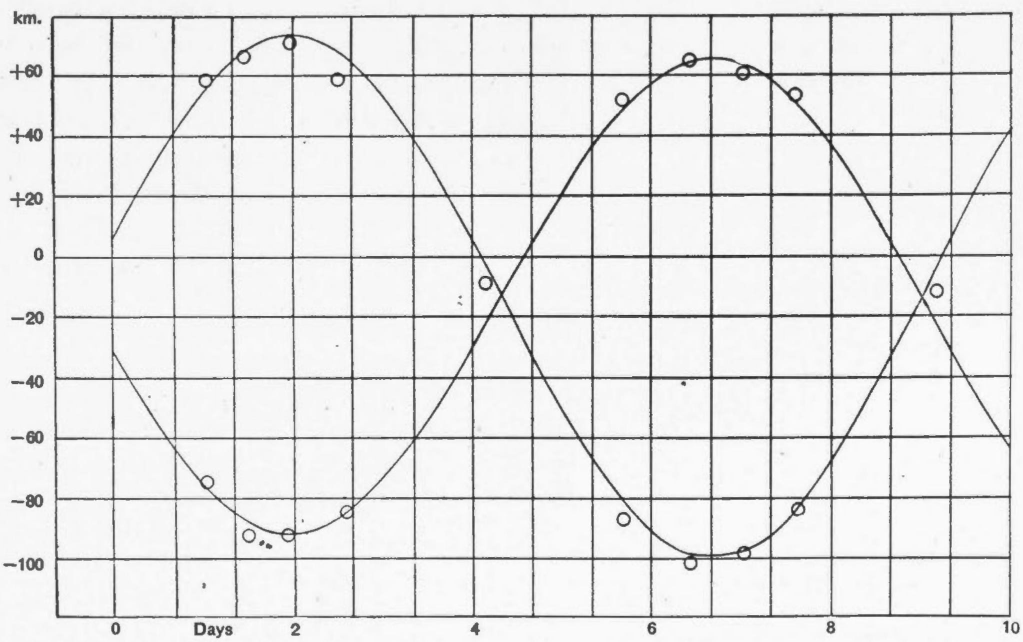
No.	x	y	y_1	z	u	$-n$	Weight
1	1·000	−0·851	....	−·769	−·447	− 5·50=0	·3
2	1·000	−0·983	....	−·514	−·207	+ 2·20	·1
3	1·000	−1·008	....	−·096	+·022	0·00	·3
4	1·000	−0·879	....	+·536	+·351	+ 2·30	·2
5	1·000	−0·064	....	+·270	+·738	−11·00	·1
6	1·000	+0·765	....	−·761	+·457	− 7·50	·15
7	1·000	+0·970	....	−·472	+·123	− 4·60	·2
8	1·000	+0·973	....	+·080	−·170	+ 0·50	·2
9	1·000	+0·819	....	+·621	−·460	− 4·80	·25
10	1·000	−0·161	....	−·028	−·791	−15·30	·15
11	1·000	....	+0·852	+·865	+·501	+ 0·60	·2
12	1·000	....	+0·975	+·620	+·259	+ 4·00	·1
13	1·000	....	+1·006	+·096	−·048	+ 1·40	·15
14	1·000	....	+0·907	−·524	−·348	+ 5·80	·15
15	1·000	....	+0·064	−·304	−·831	− 0·40	·05
16	1·000	....	−0·770	+·857	−·508	+ 5·80	·15
17	1·000	....	−0·973	+·508	−·124	+ 2·90	·1
18	1·000	....	−0·978	−·036	+·164	− 1·00	·1
19	1·000	....	−0·801	−·732	+·541	− 0·30	·2
20	1·000	....	+0·161	+·032	+·890	+11·10	·1

NORMAL EQUATIONS

$$\begin{array}{rrrrrr} 3\cdot300x & -0\cdot153y & +0\cdot054y_1 & -0\cdot005z & -0\cdot031u & -3\cdot675=0 \\ & 1\cdot412y & 0\cdot000y_1 & +0\cdot146z & +0\cdot028u & -1\cdot420=0 \\ & & 0\cdot972y_1 & +0\cdot099z & +0\cdot040u & +0\cdot725=0 \\ & & & 0\cdot991z & +0\cdot026u & +2\cdot695=0 \\ & & & & 0\cdot617u & +2\cdot076=0 \end{array}$$

Small corrections were thus obtained; the corrected or final values being given in the table above. The probable error of a plate is for the primary ±4·8 km. per sec., and for the secondary ±6·9 km. per sec. All plates were measured twice, the second measurement being made several months after the first, the means of the two measures for the various lines are given in the detailed measures.

Dominion Observatory
Ottawa
January, 1918.



Velocity Curves of Boss 5173

PUBLICATIONS
OF THE
DOMINION OBSERVATORY
OTTAWA, CANADA
Vol. IV, No. 14

ORBIT OF THE SPECTROSCOPIC BINARY BOSS 3511

BY W. E. HARPER, M.A.

This star ($\alpha = 13^h\ 30^m$, $\delta = 37°\ 42'$) was announced a spectroscopic binary by Wright and Allen in *Lick Observatory Bulletin*, No. 173, from four plates which showed a range of about 12 km. For a single-prism instrument, this range is rather small for successful work on the star but in this case the small variation in velocity is offset by an excellent F–type spectrum, the lines of which can be very accurately measured. For this reason it was placed on the programme. The star's photographic magnitude is 5·3. Thirty-two plates were secured in 1917 and six in 1918, and upon these the orbit is based. A preliminary value of the period was arrived at from a comparison of the 1917 observations with the early Lick observations. There was some uncertainty in the exact number of cycles elapsing between the two sets of observations, and the period, accepted as best at that time, required a small correction in order to suit the 1918 observations. While the period of 1·61100 days here determined suits our own observations and the 1908 and 1909 observations of the Lick Observatory, it fails to suit their 1905 observation, so that even yet some uncertainty exists though this value seems to be the only possible one from the observations.

About 15 or 20 lines were measured on each plate. Their wave-lengths are given in the following table, which shows how often they were measured, with the residuals, numerical and algebraic. These are taken in the sense, mean of plate minus line velocity. There are a few whose values should in future be adjusted but such has not been done in the case of this star.

LINES USED IN BOSS 3511

λ	n	Residual		λ	n	Residual	
		Numerical	Algebraic			Numerical	Algebraic
4584·018	14	11·2	+ 4·2	4290·053	13	6·7	+ 2·6
4572·190	28	9·2	+ 6·1	4271·675	38	4·0	+ 0·2
4549·743	38	5·1	+ 0·2	4260·537	25	3·6	+ 1·3
4534·158	12	7·3	− 0·2	4250·586	18	3·5	− 2·6
4501·417	18	9·9	− 6·0	4236·000	16	6·5	+ 0·2
4481·477	30	10·4	− 8·0	4233·425	30	6·8	− 4·7
4468·663	7	6·4	− 2·3	4227·107	5	7·4	+ 2·7
4415·345	33	5·0	− 1·9	4215·733	26	4·1	− 0·8
4404·861	22	5·5	− 2·1	4202·366	16	12·0	+11·5
4395·155	5	20·0	−17·5	4198·677	9	5·7	− 3·2
4351·977	17	9·5	− 1·4	4143·839	28	5·7	+ 1·0
4340·645	29	6·6	− 1·7	4071·865	14	4·0	+ 2·8
4325·698	25	6·2	+ 2·8	4063·730	23	5·7	+ 3·0
4307·974	29	5·1	− 0·9	4045·940	34	3·4	+ 1·4
4294·359	14	8·0	+ 5·4				

SUMMARY OF MEASURES OF BOSS 3511

Plate	Date	Julian Date	Phase	Velocity	O–C
	1905				
Mt. Wilson	June 20	2,417,017·738	1·329	+ 7·43	+ 8·0
	1908				
"	Jan. 7	7,948·049	0·482	+ 9·90	− 3·3
	1909				
"	April 17	8,414·913	0·156	+ 2·06	+ 1·3
"	" 19	8,416·867	0·499	+13·74	0·1
	1917				
8049	Feb. 11	2,421,271·906	0·846	+14·0	− 1·0
8055	" 12	272·860	0·189	+16·7	+14·9
8065	" 18	278·747	1·243	− 1·5	− 4·0
8080	" 27	287·940	0·770	+17·7	+ 2·0
8087	Mar. 1	289·869	1·088	+ 5·2	3·0
8095	" 2	290·879	0·487	+16·7	+ 3·7
8134	" 30	318·785	1·006	+ 0·9	−10·2
8140	April 8	327·710	0·265	+ 4·0	− 1·0
8144	" 10	329·784	0·728	+16·4	+ 0·2
8148	" 16	335·809	0·309	− 4·1	−10·9
8149	" 18	337·706	0·595	+12·9	2·4
8151	" 21	340·716	0·383	+ 9·0	0·6
8154	" 22	341·784	1·451	− 6·5	− 3·2
8160	" 24	343·731	0·176	− 1·0	− 2·3
8162	May 3	352·747	1·137	+ 6·8	+ 0·4
8165	" 13	362·656	1·380	− 7·1	− 5·1
8176	" 20	369·755	0·424	+13·4	+ 2·2
8185	" 29	378·758	1·372	+ 2·8	+ 4·6
8186	" 30	379·616	0·619	+17·2	+ 1·6
8190	June 3	383·736	1·517	− 2·8	+ 0·9
8191	" 5	385·582	0·141	0·0	− 0·1
8197	" 16	396·678	1·571	− 4·1	− 0·4
8200	" 18	398·598	0·269	+ 8·4	+ 3·2
8209	" 27	407·617	1·233	+12·3	+ 9·5
8213	July 2	412·598	1·391	+ 5·9	+ 7·8
8220	" 6	416·619	0·569	+15·7	+ 1·0
8226	" 16	426·608	0·892	+17·6	+ 3·5
8241	" 25	435·582	0·200	+ 4·8	+ 2·4
8244	" 27	437·588	0·593	+15·6	+ 0·3
8253	Aug. 2	443·625	0·188	− 0·9	− 2·7
8259	" 6	447·570	0·911	+13·5	− 0·2
8263	" 10	451·577	0·085	− 0·4	+ 1·2
	1918				
8448	Feb. 17	642·777	1·187	+ 4·7	+ 0·2
8462	" 26	651·790	0·534	+ 9·3	− 4·8
8467	Mar. 8	661·677	0·755	+14·1	− 2·0
8479	" 22	675·664	0·243	+ 4·3	+ 0·2
8486	April 2	686·633	1·545	− 3·4	+ 0·4
8493	" 4	2,421,688·701	0·392	+ 7·1	− 2·9

MEASURES OF BOSS 3511

λ	8049		8055		8065		8080		8087		8095		8134	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584	0·0	¼	....	....	− 9·0	1	....	....	....	....	....	....	....	....
4572	− 8·0	¼	+13·3	1	−15·7	½	....	....	....	....	....	....	....	....
4549	− 4·0	¾	+ 2·2	1	−13·1	1	+ 5·0	1	+ 4·4	1	+19·1	1	+ 6·6	1
4534	+ 7·4	½	+ 3·9	½	−10·9	1	+ 3·0	½	....	....	....	....	....	....
4528	....	....	....	....	−13·0	1	....	....	....	....	....	....	....	....
4501	....	....	....	....	−11·4	½	+ 5·6	½	+12·6	½	....	....	+ 8·4	½
4481	− 7·8	¼	− 2·7	1	+ 7·8	½	+23·1	½	− 5·5	½	....	....	+25·5	½
4468	+ 2·6	½	....	....	....	....	....	....	....	....	....	....	....	....
4415	+16·2	½	+17·2	1	−11·8	1	+ 9·6	1	+ 4·8	1	....	....	+ 0·8	½
4404	....	....	+ 3·2	1	−18·4	1	+16·4	1	+ 4·7	1	....	....	−12·0	½
4383	− 0·7	¼	− 6·0	1	....	....	....	....	....	....	....	....	....	....
4351	....	....	....	....	−24·1	1	+16·7	½	....	....	....	....	+11·0	1
4340	....	....	− 0·8	½	−18·5	½	+10·8	1	+ 4·5	1	....	....	+ 3·3	½
4325	....	....	+ 3·7	½	−25·9	1	+ 5·8	1	+ 2·2	1	6·8	¾	....	....
4307	+ 4·7	¼	+ 6·9	1	−11·9	½	+16·0	1	− 1·3	1	1·2	¾	+ 3·2	1
4290	....	....	−12·6	1	−22·0	1	+24·8	1	−11·3	1	....	....	− 4·2	½
4271	−18·9	¼	+ 0·5	1	−19·4	1	+ 7·4	1	− 9·2	1	7·7	1	+ 7·4	1
4260	....	....	....	....	....	....	+ 7·6	1	− 9·6	1	2·4	1	− 5·6	1
4250	....	....	....	....	−13·6	1	....	....	− 4·7	1	....	....	+12·1	1
4236	....	....	....	....	−25·4	1	....	....	− 3·4	1	....	....	....	....
4233	+ 6·2	½	+ 8·5	1	0·0	1	+12·9	1	+ 1·5	1	+17·8	1	− 2·1	1
4227	....	....	....	....	− 6·3	1	+ 1·0	1	....	....	....	....	....	....
4215	−15·0	¼	− 1·7	1	−15·0	½	+12·0	1	− 0·6	1	....	....	+ 2·6	½
4202	....	....	....	....	−24·0	1	0·0	1	−12·7	1	....	....	−17·0	1
4198	....	....	....	....	+ 6·0	½	....	....	− 1·0	1	....	....	....	....
4143	0·0	¾	+ 8·0	1	− 8·9	1	+ 2·5	1	− 8·8	1	....	....	....	....
4101	....	....	....	....	−12·3	½	....	....	....	....	....	....	....	....
4077	....	....	....	....	....	....	+ 5·2	1	− 6·0	1	....	....	....	....
4071	− 8·6	¼	− 3·4	1	....	....	+10·0	1	− 6·1	1	....	....	....	....
4063	....	....	....	....	− 6·8	1	+ 6·3	1	− 6·7	1	....	....	− 4·5	½
4045	+ 0·2	¾	+ 7·2	1	−13·0	1	+11·9	1	− 4·9	1	....	....	− 5·3	½
4005	....	....	....	....	....	....	0·0	1	....	....	....	....	....	....
Weighted mean	± 0·00		+ 2·84		−13·68		+ 9·01		− 2·90		+ 8·80		+ 1·75	
V_a	+14·35		+14·07		+12·25		+ 9·16		+ 8·48		+ 8·14		− 2·24	
V_d	− ·03		+ ·03		+ ·17		− ·15		− ·07		+ ·09		− ·06	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+14·0		+16·7		− 1·5		+17·7		+ 5·2		+16·7		− 0·8	

MEASURES OF BOSS 3511—*Continued*

λ	8134		8140		8144		8148		8148		8149		8151	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584	......	...	......	...	......	...	+11·6	½	+ 0·7	1	+ 0·3	¼	......	...
4572	......	...	......	...	+14·1	½	......	...	−13·3	¼	+ 7·0	¼	+ 3·6	½
4549	+10·0	1	+ 9·5	½	13·5	1	− 6·0	1	− 3·9	1	+17·1	½	+ 3·0	½
4501	......	...	......	...	......	...	+22·1	1	+28·4	½	+19·0	¼	+45·7	½
4481	+14·2	½	− 2·0	½	37·6	½	+15·0	¾	+17·5	¾	+22·6	½	+44·6	½
4468	......	...	......	...	25·8	½	− 4·7	¾	......	...	......	...	......	...
4415	+ 2·4	1	+10·0	1	21·0	¾	+ 1·9	1	+ 6·0	1	+21·0	1	......	...
4404	......	...	......	...	20·6	¾	......	...	+ 6·8	1	+15·2	½	+23·2	½
4395	......	...	......	...	16·5	½	......	...	......	...	......	...	......	...
4351	......	...	......	...	47·4	½	......	...	......	...	+23·5	½	......	...
4340	+ 0·3	½	+ 8·6	½	29·0	½	+13·1	1	+13·9	1	......	...	+32·3	½
4325	......	...	− 4·0	¾	......	...	......	...	......	...	+14·9	1	......	...
4307	+ 6·9	1	+21·2	¾	18·1	½	− 1·4	1	+ 4·2	1	......	...	+ 4·8	½
4290	......	...	......	...	26·6	¾	− 3·1	1	−12·3	1	......	...	......	...
4271	+10·3	1	+ 9·6	¾	26·2	¾	+ 5·6	¾	+ 8·8	1	+20·3	1	− 1·0	½
4260	− 2·1	1	+ 9·0	¾	19·2	1	......	...	......	...	+23·1	1	......	...
4250	+ 6·4	½	......	...	29·6	¾	+11·6	¾	......	...	+28·6	½	......	...
4236	......	...	......	...	......	...	+ 3·0	½	......	...	+29·5	1	......	...
4233	+ 0·2	1	......	...	40·9	¾	+ 4·6	1	− 0·2	1	+26·5	½	+10·4	½
4227	......	...	......	...	......	...	......	...	......	...	+25·2	½	......	...
4215	+11·3	1	+18·3	½	......	...	+ 4·5	1	− 1·1	1	......	...	......	...
4202	−20·3	1	......	...	15·2	1	−12·2	1	−13·6	1	......	...	......	...
4198	......	...	......	...	......	...	+ 9·6	1	......	...	......	...	......	...
4143	+ 7·0	½	+11·9	½	15·1	1	+ 4·6	1	+ 4·4	1	+33·2	1	......	...
4063	+16·4	½	+13·6	½	18·1	1	+ 9·2	1	+17·6	1	......	...	......	...
4045	− 5·6	½	+13·7	½	+23·8	1	+ 4·2	1	+10·7	1	......	...	......	...
Weighted mean	+ 3·45		+ 9·79		+ 23·00		+ 5·28		+ 4·14		+ 22·22		+ 19·00	
V_a	− 2·24		− 5·52		− 6·27		− 8·36		− 8·36		− 9·01		− 9·99	
V_d	− ·06		− ·02		− ·12		− ·19		− ·19		− ·07		− ·03	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 0·9		+ 4·0		+ 16·3		− 3·5		− 4·7		+ 12·9		+ 8·7	

MEASURES OF BOSS 3511—*Continued*

λ	8154		8160		8162		8165		8176		8185		8186	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584	+ 5·2	1	......	...	......	...	......	...	0·0	½	+14·7	½	+34·0	½
4572	......	...	+ 9·0	1	+ 6·7	1	− 2·7	½	......	...	12·3	½	35·4	½
4549	......	...	+18·0	1	+20·6	1	+ 8·9	1	+27·5	½	33·6	1	27·2	½
4534	− 5·1	1	+13·0	1			......	...	......	...	......	...	......	...
4522	......	...	......	...	......	...	......	...	......	...	25·7	½	......	...
4481	+20·2	1	+30·0	1	......	...	+13·0	1	46·0	½	26·6	½	44·8	½
4468	+ 8·1	½	......	...	......	...	......	...	......	...	......	...	55·8	½
4415	+ 7·0	1	+ 3·2	1	+20·2	1	+ 7·3	1	25·0	½	27·5	1	26·3	1
4404	......	...	......	...	......	...	......	...	36·7	½	27·2	½	......	...
4395	+42·3	½	......	...	......	...	......	...	......	...	......	...	......	...
4351	+13·2	1	......	...	+37·6	1	......	...	......	...	......	...	......	...
4340	+11·3	1	+16·1	1	......	...	+ 5·7	½	32·4	½	......	...	......	...
4325	− 1·9	1	+ 3·8	1	+28·3	1	+11·5	½	37·0	½	17·8	½	......	...
4307	+ 6·5	1	......	...	+25·8	1	+12·6	1	29·2	½	21·3	½	......	...
4290	− 3·7	1	+ 9·8	1	......	...	......	...	......	...	......	...	......	...
4282	......	...	+ 6·2	1	......	...	+21·9	1	62·0	½	......	...	......	...
4271	+ 1·7	1	+14·5	1	+24·5	1	+10·2	1	38·6	½	21·5	1	30·0	½
4260	......	...	+ 6·2	1	......	...	......	...	......	...	......	...	......	...
4250	+ 4·7	1	+12·4	1	+22·9	1	+14·2	1	31·3	½	......	...	41·8	½
4236	......	...	+ 1·4	1	+12·3	1	......	...	......	...	......	...	......	...
4233	+ 7·3	1	......	...	+29·6	1	+11·6	1	30·7	½	24·4	1	......	...
4227	......	...	− 2·0	1	......	...	......	...	......	...	......	...	......	...
4215	+ 5·1	1	+12·7	1	+25·0	1	+13·1	1	31·1	1	30·0	1	46·6	1
4202	−21·8	1	− 7·8	1	+16·8	1	− 2·6	1	......	...	......	...	30·7	1
4198	......	...	+19·7	1	......	...	......	...	24·7	½	......	...	35·1	½
4143	+ 4·2	1	+14·5	1	+17·4	1	+ 4·0	1	34·8	1	9·1	1	......	...
4071	......	...	......	...	+24·0	1	+ 8·0	1	26·4	1	......	...	......	...
4063	− 4·6	1	+13·6	1	+ 9·4	1	+ 6·0	1	26·7	½	22·8	½	47·8	½
4045	+ 1·5	1	+11·2	1	+14·1	1	+10·8	1	+32·6	1	+15·4	½	+34·9	½
Weighted mean	+ 4·22		+ 10·28		+ 20·95		+ 9·50		+ 31·68		+ 22·65		+ 37·11	
V_a	− 10·32		− 10·96		− 13·66		− 16·23		− 17·79		− 19·39		− 19·52	
V_d	− ·14		− ·08		− ·16		− ·03		− ·19		− ·21		− ·06	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 6·5		− 1·0		+ 6·8		− 7·0		+ 13·4		+ 2·8		+ 17·2	

MEASURES OF BOSS 3511—*Continued*

λ	8190		8191		8197		8200		8209		8213		8220	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572	+ 6·6	1			+23·5	¾			+27·5	¾	+24·9	½	+28·2	½
4549	13·7	1	+13·5	½	22·6	¾	+38·3	¾	37·0	1	16·5	½	32·1	¾
4534													29·1	½
4501	27·4	1							46·7	¾	11·9	½	36·6	½
4481					40·5	½	22·2	½	30·3	¾			57·3	¾
4415					12·1	1	32·1	1	42·0	1	29·8	1	33·0	1
4404	28·4	1	23·2	½							32·6	1		
4351									25·3	½			22·7	1
4340	9·8	1			19·3	¾	50·3	½	38·9	½	19·7	½	43·5	¾
4325			28·2	½					28·9	1	29·7	½		
4307	20·2	1	15·7	½	17·7	1			30·5	½	32·2	½	37·3	1
4294					22·2	½	18·9	1						
4290					19·2	1			26·6	1				
4271	16·2	1	34·7	½	16·0	1	26·7	1	36·4	¾	28·9	½	35·7	1
4260	20·3	1	26·0	½	19·2	1	30·6	1	31·7	½	26·1	1		
4250					20·8	1							38·3	1
4236					4·9	1	38·2	½	38·3	1				
4233	24·6	1	26·5	½	17·2	1	34·0	¾	38·2	1	44·1	1	54·1	1
4227							31·3	½						
4215					16·8	½	37·9	½	38·3	½	27·2	1	45·9	½
4202					6·0	½							27·7	¾
4198					11·8	¾							39·9	1
4143			6·0	½	17·8	½	13·2	½	28·3	½	18·2	1	40·4	1
4071			13·7	½	18·0	½			36·2	½			27·3	1
4063	13·1	1	+18·8	½			16·7	½	27·0	½			41·7	½
4045	+15·6	1			+16·8	½	+33·7	1	36·8	½	+30·5	1	+35·9	1
4005									+30·4	½				
Weighted mean	+ 17·81		+ 20·63		+ 17·50		+ 30·10		+ 34·14		+ 27·60		+ 37·17	
V_a	− 20·09		− 20·31		− 21·22		− 21·30		− 21·39		− 21·23		− 20·99	
V_d	− ·21		− ·03		− ·19		− ·10		− ·16		− ·15		− ·21	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 2·8		± 0·0		− 4·1		+ 8·4		+ 12·3		+ 5·9		+ 15·7	

MEASURES OF BOSS 3511—*Continued*

λ	8226		8241		8244		8253		8259		8263		8448	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584	...	...	...	...	...	...	+21·0	1	+38·7	½	...	...	−20·5	½
4572	+22·9	½	...	...	+30·8	½	21·0	1	13·3	½	+10·6	1	−15·4	½
4549	32·3	½	+ 2·9	½	28·2	½	24·1	1	32·0	1	13·5	1	− 1·6	1
4534	53·8	½	15·7	½	...	...	25·0	1	...	...	22·0	1	−26·2	½
4522	...	...	...	...	...	...	...	...	...	...	...	...	− 1·9	½
4501	...	...	31·3	½	...	...	...	...	47·5	½	...	...	+ 1·3	1
4481	45·4	½	...	...	48·0	½	21·8	1	34·2	½	10·9	1	...	...
4468	...	...	...	...	39·3	½	...	...	...	...	...	...	...	...
4415	41·2	1	...	...	42·0	½	...	...	30·6	½	15·7	1	− 6·6	1
4404	...	...	38·0	½	...	...	27·9	1	28·4	½	17·2	1	...	...
4395	...	...	...	...	...	...	...	...	51·3	½	...	...	...	...
4351	38·7	½	...	...	38·7	½	...	...	31·5	½	16·1	1	−25·8	½
4340	58·7	½	...	...	48·7	½	4·2	1	26·0	½	6·2	1	+ 5·5	½
4325	45·8	½	49·3	½	18·5	½	9·6	1	27·4	½	...	...	...	...
4307	...	...	...	...	23·7	½	...	...	11·6	½	19·5	1	− 2·8	½
4294	32·6	½	...	...	22·4	½	...	...	...	...	7·0	1	− 7·4	1
4290	28·8	½	24·5	½	...	...	...	...	...	...	12·5	1	−11·8	½
4271	47·8	½	14·9	½	37·8	½	19·4	1	27·4	½	3·4	1	− 3·9	½
4260	29·0	½	29·0	½	35·4	½	20·3	1	27·7	½	4·3	1	−10·6	½
4250	...	...	14·8	½	...	...	...	...	...	...	16·6	1	...	...
4236	...	...	...	...	...	...	...	...	...	...	24·4	1	− 0·6	1
4233	40·8	½	...	...	34·2	½	...	...	19·5	½	24·6	1	− 4·8	1
4215	30·3	½	...	...	...	...	7·3	1	22·4	½	...	...	− 5·2	1
4202	15·8	½	...	...	...	...	...	...	...	...	...	...	...	...
4198	...	...	...	...	37·8	½	...	...	...	...	...	...	...	...
4143	...	...	18·3	½	36·8	½	...	...	42·0	½	18·0	1	−11·9	1
4077	...	...	...	...	...	...	12·8	1	...	...	...	...	...	...
4071	...	...	...	...	...	...	...	...	...	...	...	...	− 8·0	1
4063	...	...	...	...	28·0	½	8·2	1	...	...	...	...	...	...
4045	+41·4	½	...	...	+32·7	½	+ 9·6	1	+28·2	½	+17·0	1	− 5·6	1
Weighted mean	+ 38·03		+ 23·87		+ 34·27		+ 16·60		+ 30·09		+ 14·42		− 7·76	
V_a	− 19·99		− 18·61		− 18·24		− 17·01		− 16·09		− 14·33		+ 12·63	
V_d	− ·20		− ·19		− ·18		− ·23		− ·21		− ·22		+ ·13	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 17·6		+ 4·8		+ 15·6		− 0·9		+ 13·5		− 0·4		+ 4·7	

MEASURES OF BOSS 3511—*Concluded*

λ	8462		8467		8479		8486		8493					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584	−19·8	½	...	...	...	...	+19·6	½	− 1·7	½	...	...	...	...
4572	−25·0	½	+ 6·7	½	− 7·2	1	+16·6	½	+ 8·0	¾	...	...	...	...
4563	...	...	...	...	− 6·0	1	...	...	...	...	...	...	...	...
4549	+ 2·6	1	+ 9·9	1	+ 3·3	1	− 9·5	1	+ 7·9	1	...	...	...	...
4528	+13·0	½	...	...	...	...	...	...	...	...	...	...	...	...
4501	−14·6	½	...	...	+ 9·0	½	...	...	+18·3	½	...	...	...	...
4481	+11·9	1	...	...	+26·6	½	+13·5	½	+ 6·7	1	...	...	...	...
4468	...	...	...	...	+ 3·0	½	...	...	...	...	...	...	...	...
4415	+ 6·0	½	+17·8	1	+11·0	1	−11·1	½	+20·6	1	...	...	...	...
4404	+ 3·5	½	+ 3·9	1	+ 9·2	1	− 3·5	1	+ 8·7	1	...	...	...	...
4395	...	...	+22·8	½	...	...	...	...	...	...	...	...	...	...
4383	...	...	...	...	+ 4·7	1	...	...	...	...	...	...	...	...
4351	−13·0	1	...	...	...	...	+10·0	1	...	...	...	...	...	...
4340	− 3·5	½	+ 6·4	1	...	...	...	...	+ 7·8	1	...	...	...	...
4325	− 2·8	1	+ 7·2	½	...	...	+ 2·0	1	+ 3·1	1	...	...	...	...
4307	+ 4·7	½	...	...	...	...	+16·9	½	+13·8	1	...	...	...	...
4294	...	...	− 6·3	1	−10·8	½	−22·6	½	+22·4	1	...	...	...	...
4290	...	...	...	...	...	...	+ 0·2	½	...	...	...	...	...	...
4271	+ 2·6	1	+18·1	½	− 0·3	1	− 2·7	1	+19·1	1	...	...	...	...
4260	...	...	...	...	+ 2·6	1	+ 5·0	1	+16·0	1	...	...	...	...
4250	+ 0·6	½	...	...	...	...	...	...	+14·3	1	...	...	...	...
4236	+11·2	½	+10·0	½	...	...	...	...	+ 9·2	1	...	...	...	...
4233	+11·1	½	...	...	+10·4	½	+ 4·2	1	+21·8	1	...	...	...	...
4215	+ 2·0	1	...	...	...	...	...	...	...	...	...	...	...	...
4202	...	...	+ 9·1	½	...	...	...	...	...	...	...	...	...	...
4198	...	...	...	...	...	...	+ 6·3	½	...	...	...	...	...	...
4143	+ 4·2	1	...	...	...	...	...	...	...	...	...	...	...	...
4071	+ 1·5	½	...	...	...	...	...	...	+ 3·8	½	...	...	...	...
4063	...	...	...	...	...	...	...	...	+ 2·5	1	...	...	...	...
4045	+ 0·5	½	+ 5·4	½	...	...	−26·1	1	+ 7·0	1	...	...	...	...
Weighted mean	− 0·17		+ 8·38		+ 3·47		− 0·08		+ 11·32		...		...	
V_a	+ 9·64		+ 6·11		+ 0·89		− 3·22		− 3·97		...		...	
V_d	+ ·08		− ·11		+ ·20		+ ·15		+ ·07		...		...	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		...		...	
Radial Velocity	+ 9·3		+ 14·1		+ 4·3		− 3·4		+ 7·1		...		...	

The Ottawa observations were grouped according to phase, using the period 1·61100 days, into 9 normal places of equal weight and, after preliminary elements had been obtained graphically, a least-squares solution was carried through to derive corrected values. The preliminary elements adopted were:

$$P = 1 \cdot 61100 \text{ days}$$
$$e = \cdot 05$$
$$\omega = 195°$$
$$K = 10 \cdot 5 \text{ km.}$$
$$\gamma = +7 \cdot 10 \text{ km.}$$
$$T = \text{J.D. } 2{,}417{,}018 \cdot 020$$

The most satisfactory solution was obtained when T, the time of periastron passage, was considered fixed and corrections determined for the remaining four elements, e, ω, K and γ. The period was considered determined from the early observations taken in conjunction with our own.

NORMAL PLACES

	Mean Phase	Mean Velocity	O–C
1	1·130	+ 5·98	− ·71
2	1·344	− 0·02	+ ·81
3	1·521	− 4·20	− ·29
4	·148	− 0·58	−1·05
5	·246	+ 5·70	+1·44
6	·444	+11·10	− ·68
7	·594	+15·35	+ ·04
8	·751	+16·07	− ·09
9	·883	+15·03	+ ·62

Making the substitutions,

$$x = \delta\gamma$$
$$y = \delta K$$
$$z = K \cdot \delta e$$
$$u = K \cdot \delta\omega$$

in the Lehmann-Filhés formula, the following observation equations resulted:

OBSERVATION EQUATIONS FOR BOSS 3511

No.	x	y	z	u	$-n$
1	1·000	+ ·088	+·848	−·978	+2·04=0
2	1·000	− ·693	+·434	−·751	− ·16=0
3	1·000	−1·040	−·869	−·112	+ ·37=0
4	1·000	− ·672	−·018	+·794	+ ·62=0
5	1·000	− ·308	+·729	+·978	−1·84=0
6	1·000	+ ·449	+·706	+·881	+ ·71=0
7	1·000	+ ·832	−·322	+·487	+ ·48=0
8	1·000	+ ·950	−·940	−·055	+1·00=0
9	1·000	+ ·812	−·696	−·497	+ ·59=0

NORMAL EQUATIONS

$$
\begin{aligned}
9 \cdot 000x + \cdot 418y - \cdot 128z + \cdot 747u + 3 \cdot 810 &= 0 \\
4 \cdot 572y - \cdot 945z + \cdot 060u + 2 \cdot 202 &= 0 \\
4 \cdot 163z + \cdot 504u - 1 \cdot 016 &= 0 \\
4 \cdot 381u - 2 \cdot 902 &= 0
\end{aligned}
$$

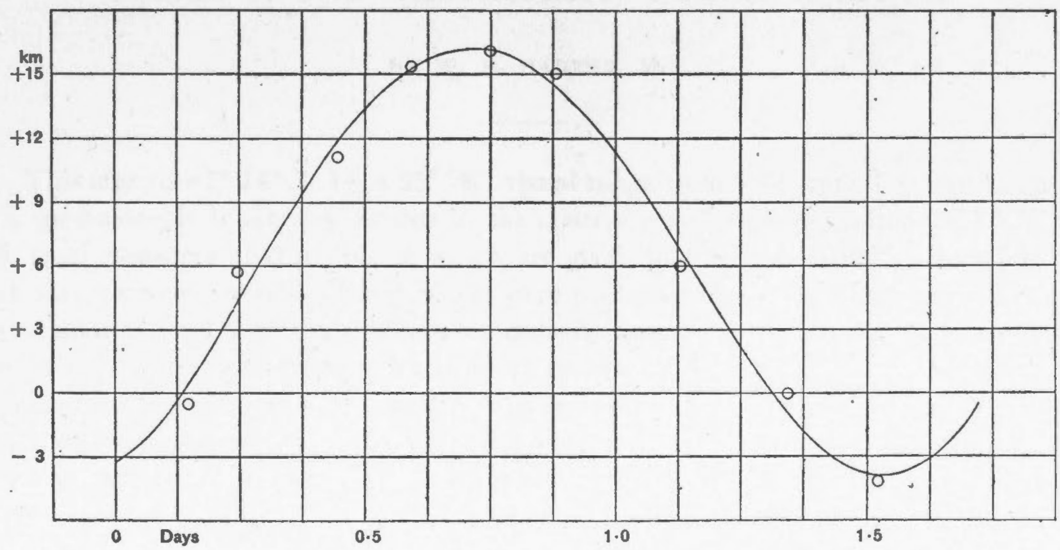
From these there resulted the small corrections,

$$
\begin{aligned}
\delta\gamma &= -\cdot 46 \text{ km.} \\
\delta K &= -\cdot 44 \text{ km.} \\
\delta e &= +\ \cdot 004 \\
\delta\omega &= +4^\circ \cdot 05
\end{aligned}
$$

so that the final values of the elements are:

$$
\begin{aligned}
P &= 1 \cdot 61100 \text{ days} \\
e &= \cdot 054 \\
\omega &= 199^\circ \cdot 05 \\
K &= 10 \cdot 06 \text{ km.} \\
\gamma &= +6 \cdot 64 \text{ km.} \\
T &= \text{J.D. } 2{,}417{,}018 \cdot 020 \\
a \sin i &= 222{,}500 \text{ km.} \\
\frac{m_1 \sin^3 i}{(m+m_1)^2} &= \cdot 0002 \odot
\end{aligned}
$$

Dominion Observatory
Ottawa
April, 1918.



Radial Velocity Curve of Boss 3511

PUBLICATIONS
OF THE
DOMINION OBSERVATORY
OTTAWA, CANADA
Vol. IV, No. 15

ORBIT OF THE SPECTROSCOPIC BINARY 19 LYNCIS

BY W. E. HARPER, M.A.

This star ($\alpha = 7^h\ 14^m.7$, $\delta = +55°\ 28'$, visual magnitude 5·61, type B8) was announced as a spectroscopic binary by Adams in the *Astrophysical Journal*, volume XXXV, page 175, from measures of three plates which are given in the table below. He stated that both spectra were present. Eight plates were made here in 1915, which gave the period approximately, and then the star was temporarily dropped from our list as it was understood that its orbit was being worked up at another observatory. It was since thought advisable to secure more plates and complete the orbit, and thirty of the thirty-seven plates whose measures follow have been used in the determination. The other seven are too uncertain by reason of the overlapping of the spectra. While the second spectrum shows occasionally on our plates, the measures of it were felt to be too unreliable to be used in the determination, and the elements obtained depend wholly on the measures of the lines due to the primary component.

TABLE OF MEASURES OF 19 LYNCIS

Plate	Date	Julian Date	Phase	Velocity	Weight	O–C
	1910					
Mt. Wilson	Dec. 23	2,419,029·965	0·593	− 80	....	−15·
	1911					
"	Jan. 11	048·986	1·537	+ 90	....	−16·
"	Jan. 17	054·917	0·689	− 6	....	....
	1915					
6697	Jan. 8	2,420,506·919	2·028	+ 10	4	− 3·
6705	" 10	508·772	1·622	+116	4	+13·
6712	" 12	510·841	1·431	+113	3	+ 8·
6716	" 15	513·917	2·247	− 61	2	− 5·
6737	" 25	523·857	0·889	+ 8	3	± 0·
6746	" 27	525·827	0·600	− 62	2	+ 1·
6752	" 28	526·840	1·613	+ 95	3	− 8·
6770	Feb. 3	532·839	0·833	± 0	3	+ 2·
	1916					
7971	Dec. 29	2,421,227·765	2·062	+ 15	2	+13·

TABLE OF MEASURES OF 19 LYNCIS—*Continued*

Plate	Date	Julian Date	Phase	Velocity	Weight	O–C
	1917					
7980	Jan. 10	2,421,239·796	0·535	− 84	1	− 8·
7983	" 11	240·641	1·380	+ 94	3	− 8·
7990	" 14	243·806	0·026	− 15	2	....
8001	" 16	245·850	2·070	+ 2	3	+ 2·
8003	" 18	247·646	1·606	+ 94	2	−10·
8020	" 30	259·762	0·164	− 96	1	− 3·
8023	Feb. 1	261·598	2·001	+ 20	3	− 2·
8046	" 11	271·760	0·865	+ 9	3	+ 7·
8054	" 12	272·802	1·907	+ 7	2	....
8059	" 15	275·658	0·243	− 98	2	+ 2·
8060	" 15	275·710	0·295	−120	1	−18·
8072	" 24	284·675	0·222	− 96	3	+ 3·
8077	" 27	287·770	1·058	+ 36	1	−13·
8125	Mar. 24	312·680	1·112	+ 82	1	+21·
8135	Apr. 3	322·541	0·935	+ 23	2	+ 4·
8289	Sept. 6	478·900	0·121	− 73	1	+14·
8379	Dec. 7	570·723	1·561	+109	1	+ 3·
8382	" 11	574·764	1·082	+ 72	1	+18·
8388	" 22	585·668	0·688	− 28	....	....
	1918					
8409	Jan. 3	597·813	1·535	+119	2	+13·
8414	" 4	598·632	0·094	+ 12	....	....
8431	" 23	617·429	0·815	+ 10	1	+20·
8443	Feb. 15	640·700	1·490	+ 92	1	−14·
8454	" 20	645·689	1·960	+ 19	....	....
8458	" 21	646·700	0·720	− 3	....	....
8461	" 26	651·720	1·212	+ 66	1	+20·
8466	Mar. 8	661·599	2·053	− 4	1	− 9·
8480	" 27	2,421,680·564	0·681	− 18	....	....

MEASURES OF 19 LYNCIS

λ	6697		6705		6712		6716		6737		6746		6752	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527													+115·9	½
4549·766	+ 16·1	¼					− 65·9	¼						
4481·400	+ 21·2	¼			+ 98·4	½	82·0	¼	+ 29·6	¼			109·7	¾
4471·676	+ 45·2	¼	+ 92·7	½									106·0	¼
4340·634	− 1·1	¾	+138·0	¾	+135·8	½	− 16·6	¼	14·7	¾	− 47·2	½	101·9	¾
4101·890									+ 15·5	¼	− 54·4	½	69·1	¼
4026·352													123·0	½
3933·825													+ 94·0	¼
Weighted mean	+ 13·20		+119·84		+117·10		− 54·83		+ 17·84		− 50·80		+106·31	
V_a	− 2·32		− 3·16		− 4·07		− 5·40		− 9·62		− 10·41		− 10·82	
V_d	− ·20		− ·09		− ·15		− ·20		− ·18		− ·18		− ·19	
Curv.	− ·28		·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 10·4		+116·3		+112·6		− 60·7		+ 7·8		− 61·7		+ 95·0	

λ	6770		7971		7980		7983		8001		8003		8003	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4522·871									− 3·8	½				
4481·400	− 14·1	½	+ 15·0	¾	−101·2	⅛	+ 88·3	¾	+ 7·9	½				
4471·676	+ 29·8	½												
4340·634	+ 25·0	½			− 66·0	⅛	+114·3	¾	+ 22·6	½	+101·0	¾	−151·6	¼
4325·939							+ 81·4	¼						
4101·890	+ 11·7	¼							− 11·0	¼				
4026·352									+ 30·8	¼				
3933·825									+ 6·0	¼				
Weighted mean	+ 13·31		+ 15·00		− 80·60		+ 98·46		+ 8·89		+101·00		−151·60	
V_a	− 13·15		+ 0·03		− 3·40		− 3·77		− 6·04		− 6·81		− 6·81	
V_d	− ·19		− ·04		− ·10		+ ·09		− ·17		+ ·05		+ ·05	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		— ·28		− ·28	
Radial Velocity	− 0·3		+ 14·7		− 84·0		+ 94·5		+ 2·4		+ 94·0		−158·6	

MEASURES OF 19 LYNCIS—*Continued*

λ	8020		8023		8046		8054		8059		8059		8060	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	...	...	...	...	...	...	...	...	− 71·1	¾	+ 94·1	½	...	...
4481·400	− 67·0	¼	+ 25·6	¼	+ 52·8	½	+ 28·4	½	− 89·8	¾	+127·0	1	...	...
4471·676	101·0	¼	30·1	½	16·1	¼	28·6	¼	...	...	...	...	− 59·5	¼
4340·634	98·4	½	53·9	¼	20·1	¾	+ 16·6	½	...	...	...	...	111·8	½
4101·890	− 54·4	¼	9·8	¼	22·9	¼	...	...	...	...	...	...	98·5	¼
4026·352	...	...	+ 47·4	¼	+ 13·6	½	...	...	...	...	...	...	−106·6	½
Weighted mean	− 83·86		+ 32·80		+ 25·73		+ 23·60		− 80·45		+116·03		−102·47	
V_a	− 11·78		− 12·50		− 16·16		− 16·51		− 17·43		− 17·43		− 17·43	
V_d	− ·10		+ ·07		− ·11		− ·15		− ·05		− ·05		− ·12	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 96·0		+ 20·1		+ 9·2		+ 6·7		− 98·2		+ 98·3		−120·3	

λ	8072		8072		8077		8125		8135		8289		8379	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	...	...	...	...	...	...	...	...	...	...	...	...	+101·7	¼
4481·400	...	...	...	...	+ 39·0	¼	...	...	...	...	...	...	...	...
4471·676	...	...	...	...	...	...	+ 97·5	¼	...	...	− 96·8	½	...	...
4340·634	− 67·8	½	+146·4	¼	63·0	¼	...	...	+ 33·9	½	− 92·8	½	+ 94·0	¼
4101·890	− 82·4	½	+127·8	¼	...	...	97·5	¼	+ 77·1	¼	...	...	...	...
4026·352	...	...	...	...	+ 35·2	½	...	...	...	...	...	...	...	...
3933·825	...	...	...	...	...	...	+117·2	½	...	...	...	...	...	...
Weighted mean	− 75·10		+137·10		+ 57·50		+107·60		+ 48·40		− 94·80		+ 97·85	
V_a	− 20·05		− 20·05		− 20·83		− 24·71		− 25·00		+ 21·98		+ 11·41	
V_d	− ·09		− ·09		− ·14		− ·14		− ·05		+ ·17		+ ·10	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 95·5		+116·7		+ 36·2		+ 82·2		+ 23·1		− 72·9		+109·1	

MEASURES OF 19 LYNCIS—*Concluded*

λ	8379		8382		8388		8409		8431		8443		8454	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	− 78·8	¼									+128·2	¼		
4549·766	129·5	¼												
4481·400			+ 54·2	¼	− 35·0	½	+105·0	½			123·1	¼	+ 34·7	½
4340·634	−154·2	¼	+ 70·9	¼	− 29·2	¼	109·0	½	− 0·2	¼			+ 41·0	½
4101·890											+ 94·2	¼		
4026·352							+147·4	½	+ 39·1	¼				
Weighted mean	−120·83		+ 62·55		− 33·07		+119·80		+ 19·45		+110·00		+ 37·85	
V_a	+ 11·41		+ 9·79		+ 5·18		− 0·19		− 8·72		− 17·37		− 18·88	
V_d	+ ·10		+ ·03		+ ·11		− ·10		+ ·04		− ·11		− ·11	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	−109·6		+ 72·1		− 28·1		+119·2		+ 10·5		+ 92·2		+ 18·6	

λ	8458		8461		8466		8480							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481·400	+ 20·0	½	+ 70·1	¼	+ 31·0	½								
4340·634	+ 12·5	½	+104·2	¼	+ 8·0	¼	+ 7·2	¼						
4101·890					+ 5·7	¼								
Weighted mean	+ 16·25		+ 87·15		+ 19·40		+ 7·20							
V_a	− 19·17		− 20·51		− 22·66		− 24·86							
V_d	− ·13		− ·15		− ·07		− ·08							
Curv.	− ·28		− ·28		− ·28		− ·28							
Radial Velocity	− 3·3		+ 66·2		− 3·6		− 18·0							

NORMAL PLACES

	Mean Phase		Mean Velocity	Weight	Residual, O−C	
	Preliminary	Final			Preliminary	Final
1	·931	·895	+ 8·9	1·2	+2·2	−0·2
2	1·152	1·116	+ 64·0	0·4	+1·9	+2·6
3	1·468	1·432	+101·9	0·7	−5·8	−3·0
4	1·625	1·589	+107·0	1·2	+0·4	+1·9
5	2·073	2·037	+ 10·5	1·3	+1·1	−0·9
6	·068	·032	− 65·0	0·3	+0·6	+2·3
7	·266	·230	−100·0	0·7	−2·4	−0·4
8	·610	·574	− 69·3	0·3	+3·2	+0·4

The period determined from our own and Mount Wilson observations was 2·25960 days. Grouping the observations according to phase into 8 normal places as above, the following preliminary elements were obtained graphically.

$$P = 2{\cdot}25960 \text{ days}$$
$$e = {\cdot}05$$
$$\omega = 120^\circ$$
$$K = 105 \text{ km.}$$
$$\gamma = +7{\cdot}12 \text{ km.}$$
$$T = \text{J. D. } 2{,}419{,}031{\cdot}596$$

Observation equations connecting the mean residuals with the elements γ, K, e, ω and T were then built up and, with the substitutions

$$x = \delta\gamma$$
$$y = \delta K$$
$$z = K.\delta e$$
$$u = K.\delta\omega$$
$$v = [2{\cdot}46688].\delta T$$

in the Lehmann-Filhés formula, the following observation equations resulted.

OBSERVATION EQUATIONS

	Weight	x	y	z	u	v	
1	1·2	1·000	− ·004	+ ·445	+ ·957	− ·914	−2·2=0
2	0·4	1·000	+ ·524	− ·594	+ ·793	− ·754	−1·9=0
3	0·7	1·000	+ ·958	− ·776	+ ·141	− ·172	+5·8=0
4	1·2	1·000	+ ·948	− ·058	− ·275	+ ·225	−0·4=0
5	1·3	1·000	+ ·022	+ ·605	−1·042	+1·085	−1·1=0
6	0·3	1·000	− ·693	− ·815	− ·787	+ ·819	−0·6=0
7	0·7	1·000	− ·997	− ·847	− ·278	+ ·252	+2·4=0
8	0·3	1·000	− ·759	+ ·821	+ ·636	− ·665	−3·2=0

From these there resulted the equations,

$$
\begin{aligned}
6\cdot100x + \cdot904y - \cdot122z - \cdot357u + \cdot385v - \cdot710 &= 0\\
2\cdot841y - \cdot118z + \cdot126u - \cdot175v + 2\cdot165 &= 0\\
2\cdot183z - \cdot042u + \cdot107v - 6\cdot769 &= 0\\
3\cdot230u - 3\cdot220v - 1\cdot876 &= 0\\
3\cdot220v + 1\cdot546 &= 0
\end{aligned}
$$

which gave the following small corrections to the preliminary values,

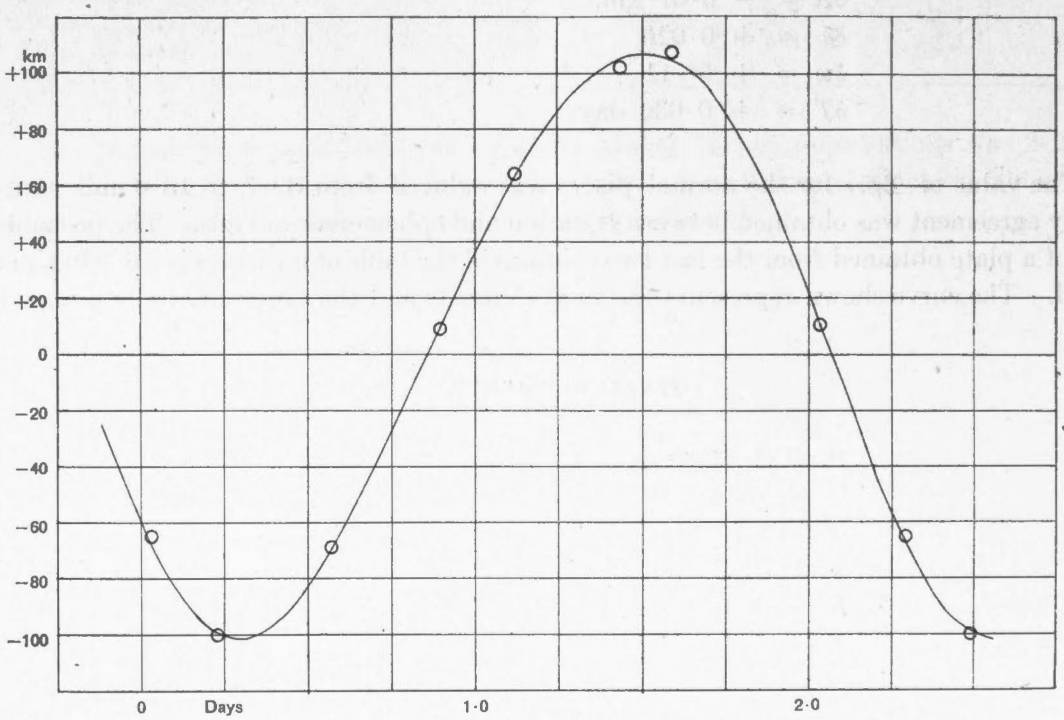
$$
\begin{aligned}
\delta\gamma &= +\ 0\cdot25 \text{ km.}\\
\delta K &= -\ 0\cdot57 \text{ km.}\\
\delta e &= +\ 0\cdot026\\
\delta\omega &= +\ 6^\circ\cdot11\\
\delta T &= +\ 0\cdot036 \text{ day}
\end{aligned}
$$

The value of Σpvv for the normal places was reduced from 39·7 to 16·0 and satisfactory agreement was obtained between equation and ephemeris residuals. The probable error of a plate obtained from the last two columns of the table of measures is ±6·9 km. per second. The curve shown represents the final elements and the observations as grouped.

FINAL ELEMENTS

$$
\begin{aligned}
P &= 2\cdot25960 \text{ days}\\
e &= \cdot076\\
\omega &= 126^\circ\cdot11\\
\gamma &= +\ 7\cdot37 \text{ km.}\\
K &= 104\cdot43 \text{ km.}\\
T &= \text{J. D. } 2{,}419{,}031\cdot632\\
a \sin i &= 3{,}235{,}400 \text{ km.}\\
\frac{m_1^3 \sin^3 i}{(m+m_1)^2} &= 0\cdot26\odot
\end{aligned}
$$

Dominion Observatory
Ottawa
July, 1918.



Radial Velocity Curve of 19 Lyncis

PUBLICATIONS
OF THE
DOMINION OBSERVATORY
OTTAWA, CANADA
Vol. IV, No. 16

ORBIT OF THE SPECTROSCOPIC BINARY *h* DRACONIS

By W. E. Harper, M.A.

This star ($\alpha = 16^h\ 56^m$, $\delta = +65°\ 16'$, photographic magnitude 5·3, type F5) was announced as a spectroscopic binary by Campbell in *Astrophysical Journal*, X, page 178. His four observations, given in the table of measures, show a range of 20 km. The star was placed on our observing programme eleven years ago, but it was not followed up until this year when 25 spectrograms were obtained with the single-prism spectrograph. This is somewhat fewer than the number of observations generally used in determining an orbit, but the lines are very good for measurement and none of the plates show large residuals from the final curve, the probable error of a plate being $\pm 1 \cdot 3$ km. per second.

About 15 or 20 lines were measured on the plates. Their wave-lengths are given in the following table, which shows also how many times they were measured and their residuals, taken in the sense, mean velocity of plate minus line-velocity.

LINES IN *h* DRACONIS

λ	Element	Times Meas-ured	Residual		λ	Element	Times Meas-ured	Residual	
			Numerical	Algebraic				Numerical	Algebraic
4572·106	*Ti*	6	7·6	−1·8	4271·755	*Fe*	24	5·0	+0·4
4549·809	*Fe-Ti*	22	7·3	+0·5	4260·604	*Fe*	16	4·9	+0·4
4531·419	*Cr-Fe*	3	0·6	−0·4	4250·593	*Fe*	9	5·0	−0·4
4501·517	*Ti*	3	3·3	−0·2	4236·121	*Fe*	12	6·6	+4·1
4481·848	*Mg*	4	11·6	−2·3	4233·475	*Mn-Fe*	15	6·8	0·0
4455·072	*Ca-Zr-Mn*	9	5·0	−1·0	4227·055	*Ca*	14	4·5	−1·3
4415·389	*Fe*	21	5·1	−0·2	4215·727	*Fe-Sr*	6	3·8	−0·6
4404·897	*Fe*	24	6·4	+0·2	4202·308	*Fe*	7	3·7	+0·3
4395·446	*Ti-V*	6	3·5	−0·9	4198·702	*Fe*	10	6·2	−2·8
4383·690	*Fe*	5	3·6	+1·2	4143·897	*Fe*	19	6·3	−0·8
4352·048	*Cr-Mg*	12	8·9	+0·2	4101·890	*H*	5	13·0	−3·6
4340·634	*H*	19	7·2	+0·5	4071·929	*Fe*	15	2·7	−0·5
4325·799	*Fe*	20	6·2	−0·5	4063·770	*Fe*	17	5·6	+0·9
4308·044	*Fe*	21	6·7	−1·2	4045·966	*Fe*	17	7·1	+0·3
4289·904	*Cr-Ti*	3	1·8	+1·8	4005·356	*Fe*	3	3·1	+0·8
4282·793	*Fe*	2	3·6	+0·8					

MEASURES OF *h* DRACONIS

Plate	Date	Julian Date	Phase	Velocity	Weight	O-C
	1899					
Lick	June 26	2,414,832·8*	19·05	−26·	....	+1·1
Lick	July 11	847·8	34·05	36·	....	+2·0
Lick	" 16	852·8	39·05	32·	....	+0·7
Lick	" 24	860·8	47·05	16·	....	−0·9
	1918					
8451	Feb. 17	2,421,642·907	3·44	1·5	19	+1·1
8471	Mar. 10	663·775	24·31	34·6	11	0·0
8482	" 27	680·710	41·24	33·2	11	−4·2
8498	April 9	693·704	2·52	2·0	17	+0·8
8501	" 14	698·720	7·54	4·2	11	+1·6
8506	" 19	703·651	12·47	13·9	16	+0·5
8510	" 22	706·647	15·47	20·7	10	−0·1
8512	" 24	708·688	17·51	25·4	15	−0·9
8517	" 26	710·667	19·49	26·4	13	+1·5
8520	May 8	722·602	31·42	40·1	14	−1·5
8521	" 8	722·656	31·48	40·3	11	−1·7
8522	" 14	728·690	37·51	35·8	12	−0·8
8525	" 20	734·657	43·48	20·4	12	+3·7
8537	June 5	750·647	7·76	6·6	2	−0·6
8539	" 7	752·693	9·80	10·3	12	−0·8
8580	" 18	763·656	20·77	28·6	7	+1·3
8593	" 25	770·610	27·72	35·0	3	+2·5
8611	July 9	784·604	41·71	27·6	12	+0·3
8617	" 12	787·684	44·79	22·8	22	−2·0
8622	" 17	792·699	49·81	9·7	17	−1·1
8639	Aug. 25	831·685	37·08	32·9	5	+2·5
8640	" 26	832·573	37·97	29·8	15	+4·5
8645	" 29	835·651	41·05	30·5	22	−1·1
8649	Sept. 13	850·550	4·24	5·3	10	−2·6
8650	" 17	2,421,854·664	8·35	− 7·1	11	−0·1

*The decimal of a day is assumed

MEASURES OF *h* DRACONIS

λ	8451		8471		8482		8498		8501		8506		8510	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572	+ 6·3	½	−21·4	1										
4549	− 6·4	½			−24·5	½	−10·0	1	−17·5	1	− 5·7	1	− 8·9	1
4531	− 3·8	½											17·9	1
4481					18·8	1			+11·8	1				
4455	−13·4	¾			15·9	½			− 1·7	1	− 9·1	1		
4415	−11·2	1	24·1	1			− 3·0	1	− 7·1	1	−16·4	1½	21·8	1
4404	−17·8	½	17·8	1	39·7	1	− 6·9	1	+ 2·2	1	−11·8	½	22·6	½
4395	− 4·6	½	38·7	1										
4383							+ 5·8	1			−16·0	1		
4352											+ 4·1	½	36·3	1
4340	+ 2·5	1	51·2	1	38·0	½	− 3·3	1	−22·5	1	−12·3	1		
4325	− 3·6	1	44·0	1			+ 4·3	1	+ 9·8	1	−16·5	1		
4308	− 7·2	1	38·8	1	38·3	1	+ 1·9	1	+11·4	1	−16·1	1		
4289	− 4·7	1					− 4·2	1						
4282	− 0·8	1												
4271	− 8·4	1½	44·8	1	32·0	1	+ 3·9	1	− 7·5	1	− 2·2	1	25·3	1
4260	− 6·5	1			31·8	1	+ 2·3	1			−14·3	1	23·5	1
4250											−17·2	½		
4236	+ 1·1	1	41·5	1	34·5	½								
4233	+ 1·7	1			35·8	1	+ 3·8	1						
4227	+ 8·2	1					− 0·5	1			− 8·9	1	11·1	½
4215											− 5·6	1		
4198							+ 4·4	1	+ 3·5	1	−10·9	½	5·4	1
4143	− 7·2	½	25·1	½	26·9	1	− 1·7	1	− 7·3	1			15·1	1
4071	− 7·7	1	34·9	½			− 4·1	1			−11·7	1	−10·7	1
4063	− 3·8	½	31·0	½	36·4	1	+ 2·4	1			−21·9	1		
4045	+ 2·1	1	−38·3	½	−41·8	1	− 1·0	1			− 9·3	1		
4005	− 0·1	1												
Weighted mean	− 3·61		−35·16		−32·54		− 0·35		− 2·26		−11·64		−18·17	
V_a	+ 2·28		+ 0·77		− 0·52		− 1·48		− 1·82		− 2·15		− 2·34	
V_d	+ 0·08		+ 0·12		+ 0·13		+ 0·12		+ 0·11		+ 0·13		+ 0·13	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 1·5		−34·6		−33·2		− 2·0		− 4·2		−13·9		−20·7	

MEASURES OF *h* DRACONIS—*Continued*

λ	8512		8517		8520		8521		8522		8525		8537	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572									−30·2	1	−18·7	1		
4549	−14·9	½	−10·2	1	−30·6	1	−31·9	1					− 1·4	½
4531							35·7	1						
4481	29·9	½	35·0	½										
4455					38·7	1	40·4	1	31·3	1	9·3	½		
4415	16·1	1	27·5	1	38·8	1			26·4	1	19·3	1	+ 5·0	¼
4404	36·0	1	26·7	1	36·1	1	39·7	1	37·1	1			− 7·4	1
4395	21·9	1			39·9	1								
4383			26·8	1					36·2	1				
4352											0·0	1		
4340			37·6	½	46·8	1	36·6	1						
4325	26·2	½	17·6	½	28·0	1	42·2	1	29·4	1				
4308	24·9	1	46·2	1	28·1	1	25·5	1	30·3	1	13·3	1	+ 9·9	¼
4271	23·6	1	18·8	1	33·6	1	40·5	1	27·8	1	9·5	1		
4260	19·0	1	24·8	1							25·5	½		
4250	14·7	1	14·6	1							19·6	½		
4236	25·9	½	13·4	1							20·8	½		
4233	42·0	½	37·8	½			34·7	1	37·6	1	13·2	1		
4227	22·8	1	27·4	½	35·1	1	47·1	1						
4215	26·1	1												
4202					31·3	1								
4198							−31·6	1	47·0	1				
4143	7·7	1	12·2	1					25·8	1	27·7	1		
4071	20·5	½			33·3	1					18·3	1		
4063	9·3	½			46·9	1					19·2	1		
4045	−32·9	1	−16·1	½	−46·7	1			−25·1	1	−24·4	½		
Weighted mean	− 22·77		− 23·60		− 36·71		− 36·90		− 32·02		− 16·43		− 2·20	
V_a	− 2·47		− 2·65		− 3·24		− 3·24		− 3·52		− 3·76		− 4·20	
V_d	+ 0·12		+ 0·12		+ 0·12		+ 0·09		+ 0·07		+ 0·07		+ 0·09	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 25·4		− 26·4		− 40·1		− 40·3		− 35·8		− 20·4		− 6·6	

MEASURES OF *h* DRACONIS—*Continued*

λ	8539		8580		8593		8611		8617		8622		8639	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572											− 2·7	½		
4549	−21·4	1	−28·2	1	−35·1	½	−21·4	1	−12·5	1	− 5·3	½	−49·1	½
4501	− 8·1	½											25·3	¼
4415	− 8·8	1	29·4	½			20·1	1	24·6	1	− 0·7	1	15·1	½
4404	− 3·1	1	8·5	½	13·7	½	31·5	1	26·6	1	− 5·1	1	29·1	½
4395													24·2	½
4352			18·7	½	54·7	¼	23·5	½	30·4	1	− 3·1	1		
4340	− 0·2	½	10·6	½	24·0	½	27·7	½	8·6	1	+ 2·8	½		
4325	+14·3	½	37·0	½	32·6	¼			9·2	1	− 3·7	1	33·0	½
4308	+ 3·9	½	24·9	½					11·9	1	+ 2·4	1		
4289	− 6·4	1												
4271	− 9·9	1	14·4	1	35·8	½	9·6	1	23·5	1½	− 8·5	1	36·3	½
4260	− 8·8	1					8·3	½	17·7	1	+ 1·3	1	25·8	¼
4250	+ 1·6	1			−31·1	¼			20·1	½				
4236			37·7	1			29·2	1	23·9	1	−14·6	1		
4233			−22·0	½					8·6	1	− 4·5	1		
4227							27·1	1	15·7	1			33·8	¼
4215									20·0	1	−10·1	1		
4202	− 1·5	1					29·3	½	16·2	1				
4198							17·3	½	20·3	1				
4143	0·0	½					27·8	½	16·7	1	−16·0	1	22·6	¼
4101									13·1	1	+ 3·2	1	54·0	½
4071							25·3	1	20·1	1	− 4·5	1	38·1	¼
4063	− 0·3	1					15·0	1	21·2	1	− 6·2	1	38·5	¼
4045							−31·9	1	20·1	1	−14·2	1	− 3·2	½
4005									−19·9	1	− 9·7	½		
Weighted mean	− 5·82		− 23·97		− 30·51		− 23·17		− 18·30		− 5·40		− 30·51	
V_o	− 4·24		− 4·34		− 4·34		− 4·13		− 3·99		− 3·90		− 1·92	
V_d	+ 0·02		+ 0·03		+ 0·10		+ 0·02		− 0·15		− 0·10		− 0·15	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28		− 0·28	
Radial Velocity	− 10·3		− 28·6		− 35·0		− 27·6		− 22·8		− 9·7		− 32·9	

MEASURES OF *h* DRACONIS—*Concluded*

λ	8640		8645		8649		8650							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572					−19·3	½								
4549	−38·3	½	−32·7	1	+ 0·5	½	− 0·1	½						
4501					− 6·7	½								
4455							− 9·1	½						
4415	27·0	1	34·1	1	− 3·1	½								
4404	18·6	1	28·0	1	− 6·3	½	− 0·1	¾						
4395					+ 1·5	½								
4383			29·4	1										
4352	25·5	½	22·4	½	− 1·4	½	− 4·9	½						
4340	22·1	½	28·3	1	+ 2·0	½	− 4·6	½						
4325	33·1	1	26·5	1	− 4·8	¾	−17·0	¾						
4308	22·4	1	29·6	1	− 7·4	¾	−16·3	¾						
4282			33·0	1										
4271	29·4	1	25·4	1	−10·1	¾	− 9·1	½						
4260	34·6	1	39·3	1			− 4·7	½						
4250			28·5	½			−15·7	½						
4236			29·0	1										
4233	35·9	1	26·7	1	+12·5	½	− 1·9	¾						
4227			28·7	1	− 2·4	½	+ 5·0	¾						
4215	25·7	1	23·2	1										
4202	30·3	½	32·3	1			− 7·6	¾						
4198			24·3	1			− 0·7	½						
4143	32·3	1	33·4	1	−10·2	½	− 6·1	½						
4101	8·2	½	20·2	1										
4071	22·1	1	22·7	1	− 0·9	1								
4063	36·8	1	23·1	1	− 9·4	¾	− 7·8	1						
4045	−19·0	1	−31·3	1			− 6·9	1						
Weighted mean	− 27·52		− 28·48		− 4·32		− 6·42							
V_a	− 1·87		− 1·66		− 0·59		− 0·28							
V_d	− 0·09		− 0·12		− 0·09		− 0·13							
Curv.	− 0·28		− 0·28		− 0·28		− 0·28							
Radial Velocity	− 29·8		− 30·5		− 5·3		− 7·1							

Our own observations when plotted gave a period around 50 days. If the correct number of cycles has been taken to connect up the Lick observations with our own, the period determined, 51·710 days, should be correct at least to the second decimal place. With this period, the Ottawa observations were grouped according to phase into 11 normal places and graphical elements determined as follows:

$$P = 51\cdot 710 \text{ days}$$
$$e = \cdot 15$$
$$\omega = 330°$$
$$K = 18\cdot 25 \text{ km.}$$
$$\gamma = -22\cdot 62 \text{ km.}$$
$$T = \text{J. D. } 2{,}414{,}813\cdot 93$$

NORMAL PLACES

	Final Mean Phase	Mean Velocity	Weight	Final O–C		Final Mean Phase	Mean Velocity	Weight	Final O–C
1	19·94	−27·17	2·0	+1·32	7	49·81	−9·70	1·5	−1·13
2	25·04	34·70	1·5	+0·59	8	3·01	1·74	3·5	+0·98
3	31·45	40·19	2·5	−1·62	9	6·84	5·60	3·5	−0·66
4	38·57	32·68	4·0	+0·98	10	11·33	12·36	2·5	+0·05
5	41·29	29·48	3·5	−0·50	11	16·69	−23·52	2·5	−0·51
6	44·32	−21·95	3·5	+0·12					

Using the differential formula of Lehmann-Filhés, observation equations were built up connecting the residuals with the elements whose values were to be improved upon, namely, γ, K, e, ω and T. In the equations, weighted as above, substitutions were made as follows:

$$x = \delta\gamma$$
$$y = \delta K$$
$$z = K\cdot\delta e$$
$$u = K\cdot\delta\omega$$
$$v = [0\cdot 36069]\ \delta T$$

OBSERVATION EQUATIONS FOR *h* DRACONIS

	x	y	z	u	v	
1........................	1·000	−0·321	−0·071	−0·818	+0·683	−1·57 = 0
2........................	1·000	−0·687	+0·767	−0·501	+0·417	−0·46
3........................	1·000	−0·870	+0·890	+0·049	+0·020	+1·69
4........................	1·000	−0·630	−0·355	+0·724	−0·586	−1·44
5........................	1·000	−0·385	−0·885	+0·932	−0·852	−0·17
6........................	1·000	−0·006	−1·064	+1·066	−1·107	−0·78
7........................	1·000	+0·777	+0·303	+0·838	−0·993	+1·26
8........................	1·000	+1·028	+0·924	+0·134	−0·076	−0·30
9........................	1·000	+0·990	−0·078	−0·435	+0·588	+1·05
10........................	1·000	+0·556	−0·967	−0·830	+0·882	−0·12
11........................	1·000	−0·030	−0·625	−0·912	+0·808	+0·35

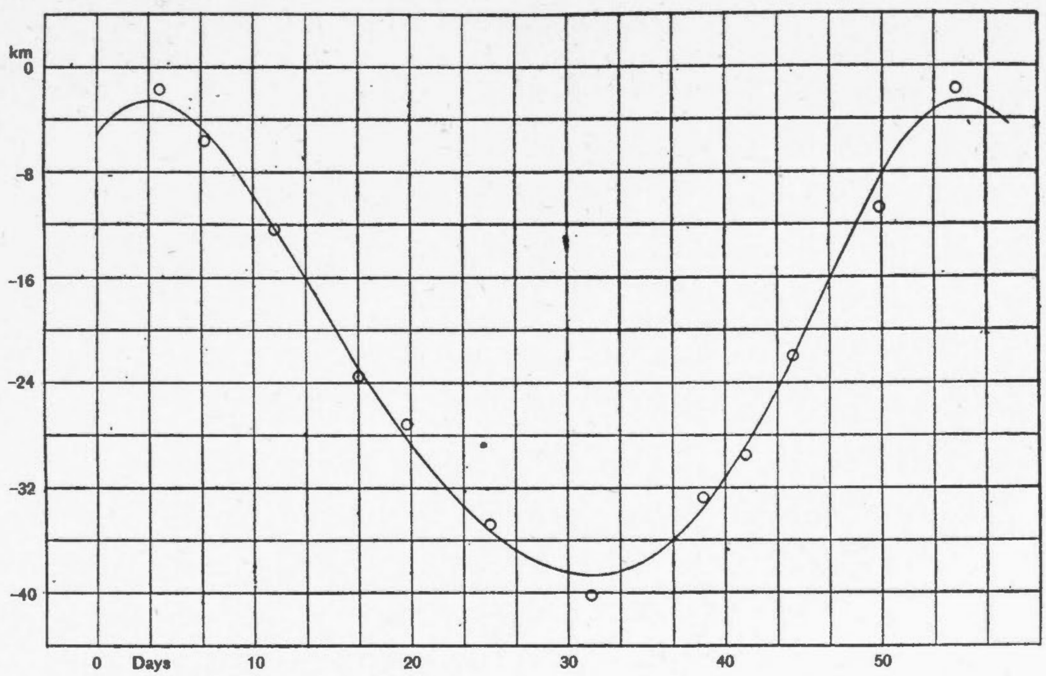
NORMAL EQUATIONS

$$
\begin{array}{rrrrrrl}
3\cdot050x & +\cdot182y & -\cdot557z & +\cdot349u & -\cdot266v & -\cdot304 & =0 \\
 & 1\cdot368y & +\cdot155z & -\cdot332u & +\cdot352v & +\cdot531 & =0 \\
 & & 1\cdot658z & -\cdot386u & +\cdot371v & +\cdot795 & =0 \\
 & & & 1\cdot639u & -1\cdot587v & -\cdot568 & =0 \\
 & & & & 1\cdot569v & +\cdot569 & =0
\end{array}
$$

From these there resulted small corrections to the elements with a corresponding reduction of Σpvv for the normal places from 29·6 to 22·2. The final elements are:

$$
\begin{aligned}
P &= 51\cdot710 \text{ days} \\
e &= \cdot128 \pm \cdot035 \\
\omega &= 329^\circ\cdot32 \pm 14^\circ\cdot09 \\
K &= 17\cdot96 \text{ km.} \pm \cdot70 \text{ km.} \\
\gamma &= -22\cdot59 \text{ km.} \pm \cdot47 \text{ km.} \\
T &= \text{J. D. } 2{,}414{,}813\cdot75 \pm 1\cdot996 \text{ days} \\
a \sin i &= 12{,}625{,}000 \text{ km.} \\
\frac{m_1^3 \sin^3 i}{(m+m_1)^2} &= \cdot03 \odot
\end{aligned}
$$

Dominion Observatory
Ottawa
October, 1918.



Radial Velocity Curve of *h* Draconis

PUBLICATIONS
OF THE
DOMINION OBSERVATORY
OTTAWA, CANADA
Vol. IV, No. 17

MEASURES OF THE RADIAL VELOCITIES OF FOURTEEN STARS

By J. B. CANNON, M.A.

BOSS 154

($\alpha = 0^h\ 40^m \cdot 5$, $\delta = +54^\circ\ 46'$, spectral type A, mag. 5·5)

Plate	Date	Julian Day	Velocity
	1917		
8262	Aug. 6	2,421,447·832	− 7·4
8298	Sept. 12	484·790	−17·4
8309	Sept. 24	496·852	− 2·5
8324	Oct. 15	517·782	−12·3
8368	Nov. 29	562·617	−14·3
	1918		
8405	Jan. 3	597·517	− 3·2

Professor Frost has three measures of this star which show a range of 40 km. The first of his plates shows both components, the velocity from the main component being −24 km., and that of the other +115 km. Only one component was shown by our plates.

1 PERSEI

($\alpha = 1^h\ 45^m \cdot 4$, $\delta = +54^\circ\ 39'$, spectral type B3, mag. 5·49)

Plate	Date	Julian Day	Velocity
	1914		
6304	Aug. 24	2,420,369·875	−37·3
6339	Sept. 4	380·873	−13·0
6359	Sept. 11	387·849	− 7·2
6379	Sept. 15	391·737	−45·2
6402	Sept. 18	394·770	−36·8
6442	Sept. 28	404·809	+28·7
	1916		
7782	Aug. 14	2,421,090·817	−17·4
7791	Aug. 16	092·847	−67·8

In *Ap. J.*, XXXV, 172, are given four observations by Adams having a range of 100 km. The spectrum is very poor and the probable error of a plate large.

σ HYDRÆ

($\alpha = 8^h\ 33^m \cdot 5$, $\delta = +3°\ 41' \cdot 5$, spectral type K5, mag. 4·54)

Plate	Date	Julian Day	Velocity
	1917		
8092	Mar. 2	2,421,290·672	+18·8

Campbell's "Observed Velocity" (*L.O.B.*, VII, No. 229) is +27·8.

η HYDRÆ

($\alpha = 8^h\ 38^m \cdot 0$, $\delta = +3°\ 46'$, spectral type B3, mag. 4·32)

Plate	Date	Julian Day	Velocity
	1917		
8108	Mar. 12	2,421,300·632	+26·0
	1918		
8457	Feb. 21	646·648	+33·4
8459	Feb. 26	651·567	+22·2
8465	Mar. 3	656·686	+37·3
8483	Mar. 28	681·593	+26·9
8491	Apr. 4	688·600	+22·0
		Mean	+28·0

Frost and Adams publish three measures of this star in *Astrophysical Journal*, XIX, page 155, having a range of 22 km.—from +4 to +26.

α HYDRÆ

($\alpha = 9^h\ 22^m \cdot 7$, $\delta = -8°\ 14'$, spectral type K2, mag. 2·2)

Plate	Date	Julian Day	Velocity
	1917		
8090	Mar. 2	2,421,290·626	−19·7
8091	Mar. 2	290·637	−19·8
8104	Mar. 9	297·622	− 9·3
8105	Mar. 9	297·634	−15·6
	1918		
8445	Feb. 17	642·658	− 9·3
8446	Feb. 17	642·669	− 6·1
		Mean	−13·3

In *A. N.*, 196, p. 389, Hnatek publishes seven observations having a range of 9 km.—from +10·8 to +19·8. Campbell in *L.O.B.*, VII, No. 229, gives the "Observed Velocity" as −3·5.

26 URSÆ MAJORIS

($\alpha = 9^h\ 29^m \cdot 0$, $\delta = +52° \ 25'$, spectral type A, mag. 4·65)

Plate	Date	Julian Day	Velocity
	1918		
8474	Mar. 17	2,421,670·671	+23·8
8484	Mar. 28	681·634	+19·5
8492	Apr. 4	688·640	+26·3
		Mean	+23·2

ζ 36 LEONIS

($\alpha = 10^h\ 11^m \cdot 1$, $\delta = +23° \ 55'$, spectral type F, mag. 3·65)

Plate	Date	Julian Day	Velocity
	1917		
8127	Mar. 26	2,421,314·731	−17·3

Campbell (*L.O.B.*, VI, No. 199) gives six measures ranging from −5·5 to −26·7.

BOSS 2802

($\alpha = 10^h\ 27^m \cdot 5$, $\delta = +40° \ 57'$, spectral type F, mag. 4·84)

Plate	Date	Julian Day	Velocity
	1918		
8516	Apr. 25	2,421,709·619	+47·7
8519	May 1	715·625	+21·6

Campbell gives as the "Observed Velocity" of this star +18 (*L.O.B.*, VII, No. 229).

ξ URSÆ MAJORIS

($\alpha = 11^h\ 12^m \cdot 9$, $\delta = +32° \ 6'$, spectral type G, mag. 4·41)

Plate	Date	Julian Day	Velocity
	1918		
8497	Apr. 9	2,421,693·628	−29·9
8515	Apr. 25	709·565	−27·0

Campbell and Wright (*Ap. J.*, XII, p. 254) give ten measures ranging from −21·9 to −8·4. Küstner gives four measures (*A. N.*, 4750), range −22·5 to −16·4. Campbell's "Observed Velocity" (*L.O.B.*, VII, No. 229) is −16.

12 COMÆ

($\alpha = 12^h\ 17^m \cdot 5$, $\delta = +26°\ 24'$, spectral type Gp, mag. 4·78)

Plate	Date	Julian Day	Velocity
	1917		
8172	May. 18	2,421,367·670	−18·9

This star is announced a binary in *L.O.B.*, VI, 182, from five measures ranging from −2·6 to −20·2.

12 H DRACONIS

($\alpha = 12^h\ 17^m \cdot 5$, $\delta = +62°\ 55'$, spectral type A2, mag. 5·13)

Plate	Date	Julian Day	Velocity
	1917		
8128	Mar. 26	2,421,314·792	+ 2·8
8156	Apr. 23	342·813	+17·6
8161	Apr. 25	344·647	+18·8
8163	May 3	352·814	−23·7
8180	May 27	376·718	−15·2
8184	May 29	378·691	−31·8
8188	May 30	379·768	−14·6
8193	June 5	385·764	− 2·9
8198	June 16	396·755	+ 2·7
8211	June 27	407·761	− 8·1
8216	July 5	415·600	+ 3·6
8223	July 15	425·635	−16·8
	1918		
8488	Apr. 2	686·866	−17·0
8507	Apr. 19	703·797	−11·7
8514	Apr. 24	708·818	+21·5
8531	May 28	742·654	−27·6

A period of 24·39 days suits all the above observations with the exception of No. 8488 which is dependent on the measure of one line only. This period also suits four Allegheny measures published by Jordan.

24 CANIS VENATICORUM

($\alpha = 13^h\ 30^m \cdot 4$, $\delta = +49°\ 31' \cdot 6$, spectral type A3, mag. 4·63)

Plate	Date	Julian Day	Velocity
	1915		
6910	Apr. 7	2,420,595·844	− 9·7
	1916		
7668	May 25	2,421,609·618	−31·4

Lee gives eight observations (*Ap. J.*, XXXIX, p. 40) in all of which he has measured both components. Campbell gives −19 as the "Observed Velocity" in *L.O.B.*, VII, No. 211, and −16 in No. 229 of the same volume, from more observations.

70 HERCULIS

($\alpha = 17^h\ 16^m \cdot 8$, $\delta = +24° \ 35' \cdot 9$, spectral type A, mag. 5·12)

Plate	Date	Julian Day	Velocity
	1917		
8227	July 16	2,421,426·657	−35·4
	1918		
8502	Apr. 14	698·818	+16·4
8513	Apr. 24	708·764	+ 5·3
8526	May 20	734·751	−22·1

Adams gives the results of three Mount Wilson observations in *Astrophysical Journal*, vol. XXXV, page 177. His velocities are −18, −26, and −3 km. per second.

BOSS 5102

($\alpha = 19^h\ 52^m \cdot 9$, $\delta = +38° \ 15'$, spectral type B3, mag. 4·9)

Plate	Date	Julian Day	Velocity
	1917		
8255	Aug. 2	2,421,443·771	−24·3
8273	Aug. 21	462·642	−39·0
8283	Sept. 6	478·620	−26·7
8293	Sept. 9	491·641	−40·0
		Mean	−32·5

Campbell, in *L.O.B.*, VI, No. 195, gives the velocity of this star as −35·0 km. per second.

Dominion Observatory
Ottawa
December, 1918.

PUBLICATIONS
OF THE
DOMINION OBSERVATORY
OTTAWA, CANADA

Vol. IV, No. 18

THE NEW STAR IN THE CONSTELLATION AQUILA

By W. E. HARPER, M.A.

The telegraphic announcement of a new star in Aquila was received here on June 9, 1918, and communicated to the writer on the afternoon of the same date. It was cloudy here the previous evening when the star was discovered by so many observers in Europe and the United States, but, fortunately, a good proportion of the nights during the remainder of June and the month of July were clear, or partly so, so that a good series of spectrograms were secured during this time when the star was changing rapidly in brightness and in the character of its spectrum. On 35 nights during June and July it was spectrographed using the single-prism instrument, having a dispersion of 33·5 angstroms per millimètre at $H\gamma$ and covering the region roughly from λ 3850 to λ 5030. Seed 27 plates were used in all but a few instances. After the end of July it was not felt necessary to photograph so often, since the changes were taking place more leisurely, and plates were secured on only 19 nights from that time up to the date of the last observation on December 17. Altogether about 140 spectra were made.

From a star of approximately the 11th magnitude on June 5 it rose to one of magnitude $-$ 1·5 on June 9, thus increasing in brightness nearly 100,000-fold in four days. The increase may have been still more rapid as there is no authentic record of it on the 6th. From its maximum brilliancy on the 9th it rapidly diminished in brightness until about the 29th of June when its magnitude was 3·8. It then began to oscillate in brightness though gradually tending to become fainter. These variations will be better established when the definite light curve is issued by Harvard, but for the present approximate results which are the means of four observers, Messrs. Stewart, DeLury, Pearce and the writer, will be used. Minima occurred on June 29, July 11, July 22, August 3, August 14 and August 23; while maxima fell around July 3, July 15, July 27, August 8, August 18 and August 27, the average period being 11 days and the range of variation about $0\cdot6^m$. The time required for the star to pass from a minimum to a maximum was on the average only two-thirds the time required for it to fall from a maximum to the next minimum. Cepheid variables are also characterized by a more rapid rise than decline and this resemblance, while it should not be strained, should nevertheless be noted. It should also be noted that the photographic records of the star, which give its history back as far as 1888, show it to have been variable over a range of at least 2 magnitudes. In the case of Nova Persei (1901) the oscillations in brightness began about the same length of time after maximum brilliancy, but their period was much shorter and the range much greater. The average range was $1 \cdot 5^m$ accomplished in a period of roughly 3 days and these oscillations continued for about 100 days.

At the end of August the star was about $4 \cdot 5^m$ and through September diminished with smaller oscillations to a little brighter than $5 \cdot 0^m$, which brightness it maintained through October and November, decreasing to between $5 \cdot 5^m$ and $6 \cdot 0^m$ by the middle of December. In the table which follows, the estimates of brightness were made by comparing the nova with surrounding stars using their magnitudes as given in *Harvard Annals*, Vol. 50. For the first two nights, comparison was made principally with Vega and a correction should have been made for the different zenith distances but such has not been done. When the star became fainter it was possible to select stars of about the same zenith distance, thereby doing away with the necessity of considering this factor. The star field issued by Harvard College Observatory in Bulletin 661 was found very convenient in making the estimations of brightness. When the star became fainter than the 4th magnitude it is possible that our estimations were vitiated by the light from the $6 \cdot 26^m$ star, 17 minutes of arc, to the northeast. While the nova was of the 4th magnitude, or brighter, the additional light of this star would never cause more than $0 \cdot 1^m$ of a difference, but as the nova became fainter the light from the nearby star would have an increasing influence on the combined brightness amounting to $0 \cdot 3^m$ when the nova was of 5th magnitude. On certain nights, while the star was of about this brightness, the nova had a fuzzy appearance and, while ordinarily at Ottawa a $6 \cdot 26^m$ star can not be seen with the unaided eye, its blended light may have been the cause of the peculiar blurred appearance. In any event no allowance was made for its effect; the combined light was recorded. For these and other reasons the magnitudes given are not claimed to be exact, but the means, which are given to tenths only, should be close approximations and after the first few days should not be in error much over $0 \cdot 2^m$ at the outside. One instance will show that small variations can be detected by the unaided eye. One night the star was midway in brightness between two stars on either side of it in the sky, δ Aquilæ ($3 \cdot 44^m$) and η Serpentis ($3 \cdot 42^m$), and while either one or both may be in error or may be variable in light it is not likely that the difference would amount to more than $0 \cdot 2^m$, and there was no doubt about saying that the nova was brighter than δ Aquilæ and fainter than η Serpentis. On June 25 also in my notes is entered "η Serpentis, type K, certainly appears brighter than δ Aquilæ, type F."

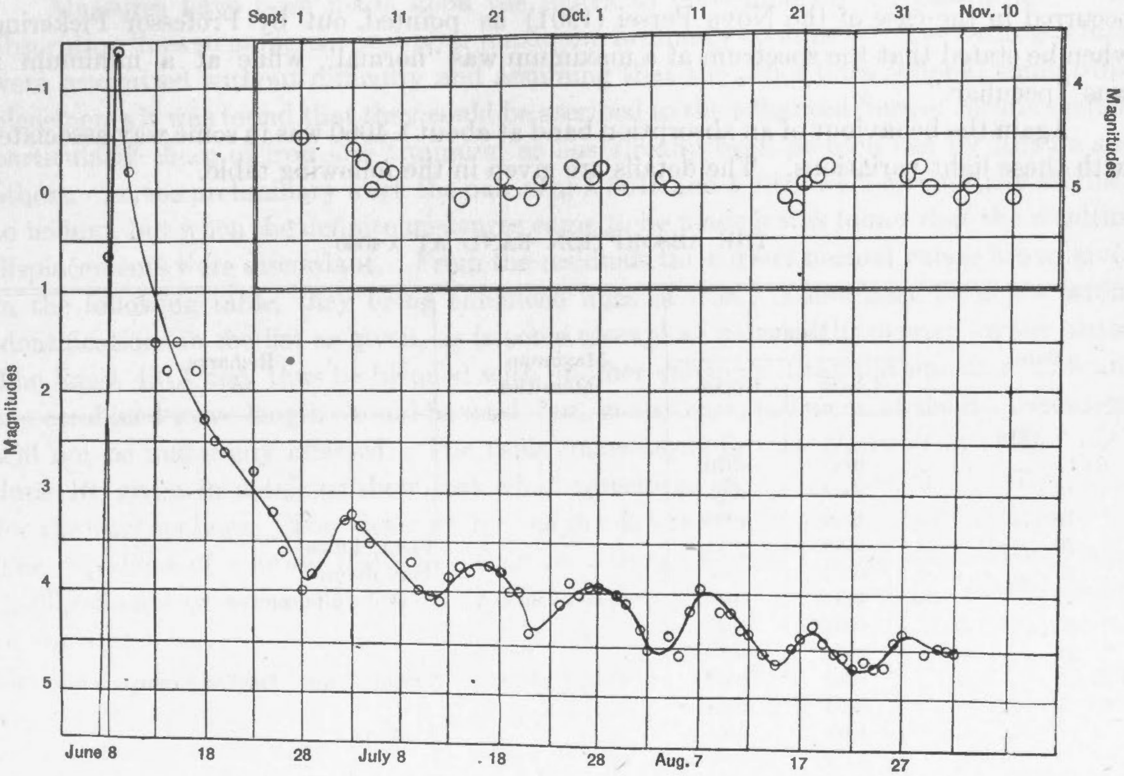
NAKED EYE ESTIMATES OF MAGNITUDE OF NOVA AQUILÆ No. 3

	Harper	DeLury	Pearce	Stewart	Means
1918					
June 9·6	−0·4				−0·4
" 10·6	0·2				+0·2
" 13·6	1·5				1·5
" 14·6	1·8				1·8
" 15·6	1·5	1·4			1·5
" 17·6	2·2	1·4			1·8
" 18·6	2·3				2·3
" 19·6	2·5				2·5
" 20·6	2·6				2·6
" 23·6	2·8				2·8
" 25·6	3·2	3·2			3·2
" 26·6	3·6	3·6			3·6
" 28·6		4·0			4·0
" 29·6	3·8	3·9			3·8
July 2·6	3·4		3·2	3·2	3·3
" 3·6	3·2	3·1		3·4	3·2
" 4·6	3·4	3·3		3·3	3·3
" 5·6	3·5				3·5
" 9·6	3·7	3·6		3·7	3·7
" 10·6	4·1	4·0		3·8	4·0
" 11·6	4·1	3·9	4·1		4·0
" 12·6	4·1	4·0	4·1	4·1	4·1
" 13·6	3·9	3·7	3·9	3·9	3·9
" 14·6	3·8	3·8	3·6		3·8
" 15·6	3·8	3·9	3·6	3·8	3·8
" 17·6	3·8	3·9	3·6	3·7	3·7
" 18·6	3·9	3·8		3·7	3·8
" 19·6	4·0	3·9	4·0		4·0
" 20·6	4·1	3·9			4·0
" 21·6	4·3		4·5		4·4
" 24·6			4·1		4·1
" 25·6			3·9		3·9
" 26·6	4·1		3·9		4·0
" 27·6	4·0	3·9	3·9		3·9
" 28·6	4·0	4·0	3·9	3·9	4·0
" 30·6	4·1	4·0	4·0	4·0	4·0
" 31·6	4·2	4·1	4·2	4·0	4·1
Aug. 1·6	4·4	4·4	4·3		4·4
" 2·6	4·3	4·6	4·7	4·5	4·5
" 4·6	4·4				4·4
" 5·6	4·6				4·6
" 6·6	4·2	4·1			4·2
" 7·6	4·0		3·9		4·0
" 9·6	4·1		4·3	4·0	4·1
" 10·6	4·2	4·1			4·2
" 11·6	4·3	4·2	4·5		4·3
" 12·6	4·4	4·2			4·3
" 13·6	4·5	4·5	4·7		4·6
" 14·6	4·6		4·7		4·6
" 15·6	4·7				4·7
" 16·6	4·5		4·5		4·5
" 17·6	4·3	4·5			4·4
" 18·6	4·3		4·3		4·3
" 19·6	4·4		4·5		4·4
" 20·6		4·4	4·7		4·6
" 21·6	4·3	4·4	4·9		4·6

NAKED EYE ESTIMATES OF MAGNITUDE OF NOVA AQUILÆ No. 3—*Concluded*

	Harper	DeLury	Pearce	Stewart	Means
Aug. 22·6			4·7		4·7
" 23·6	4·6		4·7		4·6
" 24·6	4·6	4·6	4·8		4·7
" 25·6	4·6	4·6	4·9		4·7
" 26·6	4·5	4·4	4·6	4·4	4·5
" 27·6	4·4			4·3	4·4
" 29·6	4·5			4·6	4·6
" 30·6	4·6	4·4			4·5
" 31·6		4·5			4·5
Sept. 1·6		4·5			4·5
" 6·6		4·5	4·7		4·6
" 7·6	4·8	4·5	4·9		4·7
" 8·6			5·0		5·0
" 9·6	4·8	4·6	4·9		4·8
" 10·6	4·8	4·7	4·9	4·9	4·8
" 17·6	5·0	5·0	5·3		5·2
" 21·6	4·9	4·5			4·7
" 22·6	4·9	4·6	5·2		4·9
" 24·6	5·1	4·7	5·4		5·1
" 25·57	4·9				4·9
" 28·54	4·8				4·8
" 30·59	4·9				4·9
Oct. 1·56	4·8				4·8
" 3·57	5·0				5·0
" 7·62	4·9				4·9
" 8·59	5·0				5·0
" 19·5	5·1 (4-inch)				5·1
" 20·		5·2			5·2
" 21·5	4·9	5·0			5·0
" 22·52	4·9				4·9
" 23·58	4·8				4·8
" 31·54	4·9				4·9
Nov. 1·52	4·8				4·8
" 2·48	5·0				5·0
" 5·50	5·1				5·1
" 6·		5·0			5·0
" 10·49	5·1				5·1
Dec. 1·48	5·2				5·2
" 10·48	5·7 (4-inch)				5·7
" 17·48	5·8 (4-inch)				5·8
1919*					
Feb. 10·95	6·1 (4-inch)				6·1
" 19·91	6·4 (4-inch)				6·4
Mar. 13·92	6·8 (4-inch)				6·8

*Added while going through the press.



Estimated Magnitudes of Nova Aquilæ No. 3

The spectrum on June 9 was of a continuous nature with broad absorption lines due principally to hydrogen. The next night showed the characteristic "nova" type of spectrum, the broad emission bands appearing and being flanked on their violet edges by pairs of absorption lines. Numerous other absorption lines were shown, as may be seen from an accompanying table. This persisted for a couple of nights, when the continuous spectrum weakened and the fainter of the absorption lines were lost. With their disappearance the emission band at λ 4640 began to make its appearance, being fairly noticeable on the 14th and becoming equally prominent with the hydrogen emissions before the end of the month. The nebular emission N_1 (λ 5007) seems to show first about June 18. The other nebulium bands λ 4686, λ 4363 and λ 4959 developed later in the order given, λ 4686 being seen at the minimum June 29, it and λ 4363 at minimum on July 11, while λ 4959 developed a few days later, though remaining very weak till the end of July. Since then the light from the star has been almost wholly emissive in character, with the general tendency for the nebular and λ 4640 emissions to equal in intensity those of hydrogen. A more detailed description is given later.

In connection with the variations in brightness it may be pointed out here, that every increase of brightness was accompanied by a return of the continuous spectrum which in turn faded as the star diminished in brightness. This is similar to what occurred in the case of the Nova Persei (1901) as pointed out by Professor Pickering, when he stated that the spectrum at a maximum was "normal" while at a minimum it was "peculiar."

Again the behaviour of an absorption band at about λ 4060 was in some way associated with these light variations. The details are given in the following table.

THE ABSORPTION BAND AT λ 4060

Date	Limits		Maximum Intensities		Remarks
	Lower	Upper			
1918					
June 17	4058	4070			
" 18	4062	4068			
" 19	4056	4068			
" 20	4058	4071	....	....	Faint, diffuse
" 23	4053	4066	....	....	Very diffuse
" 25	4051	4064	4054·7	4059·7	Very definite centres
" 26	4062	4075			
" 29	4064	4075			
July 2	4049	4064	4053	4060	Definite limits, indefinite centres
" 3	4054	4067			
" 4	4051	4064	....	....	Uniform
" 5	4054	4066	4057·1	4062·1	
" 6	4054	4066	....	....	Red edge diffuse
" 9	4046	4053	....	....	Usual band absent, new one
" 10	4062	4075	....	....	Tendency 4048 also
" 11	4046	4075	....	....	Slight break between merged bands
" 12	4065	4075	....	....	Faint, diffuse; band 4048 suspected
" 13	4046	4054	....	....	Faint diffuse band
" 14	4049	4053	....	....	Narrow defined band
" 15	4050	4054			
" 17	....	....	4051·4	4058·0	Intense lines, violet stronger
" 18	4046	4049	....	....	Not pronounced
" 19	4062	4076	....	....	Centres possible at 4048, 4053
" 20	4065	4074	....	....	Not pronounced
" 21	4068	4074			
" 25	4065	4073	....	....	Very faint, suspect 4048
" 26	4063	4077	....	....	Very faint
" 30	4064	4076	....	....	4045-4052, both diffuse
" 31	4063	4074	....	....	4046-4052, both diffuse
Aug. 1	4068	4075			

Comparing the data with the light curve, it would appear that the band seems to shift to the red at a minimum and in the opposite direction during a maximum, that is, that different absorption lines or series of lines are present in the two cases. The rule does not hold definitely, but seems to fit the case most of the time. Thus, during the two minima, June 26 to 29 and July 10 to 12, the band is to be read from λ 4063 to λ 4075, while at the maximum, July 2 to 6, it is at λ 4052 to λ 4065. July 9 seems to be a transition date with the former band absent and a new one at λ 4048 showing. Former novæ have been characterized by somewhat similar behaviour of this band, and the combined data should establish some definite connection between the quantity and quality of light.

Measures have been made upon the plates to determine the displacements of the absorption lines so numerous just after maximum brilliancy on June 9. The hydrogen lines were recognized without difficulty and assuming that the other lines suffered similar displacements it was found that they could be ascribed to the enhanced lines of certain metals, particularly those of iron and titanium, as has already been pointed out by Adams and others. In the preliminary work the pair near λ 5016 and λ 4922 were erroneously ascribed to helium, but when the definite measures came to be made it was found that the resulting displacements were discordant. From the residuals the correct normal values are as given in the following table, they being enhanced lines of iron. There may be a few wrong identifications in the list as given, as in some cases close pairs might overlap on our plates. The line λ 4313 may thus be blended with another enhanced titanium line at λ 4315 and the combined wave-length should be used, but, in any case, the mean of the displacements will not be materially affected. The table following is for the plates of one night only, June 10, given in detail to show just what agreement existed among the displacements for the various lines. The measures for the displacements on other dates follow later on. The expedient of quoting them as velocities is used, though it is not implied that these displacements are necessarily due to velocities of outrushing gases, much less to the velocity of the star itself. A summary follows for the other dates. The velocities obtained for the sharp calcium lines, *H* and *K*, show that within the limits of error they are constant and have a mean value of − 19·9 km. ± 0·7 km. per second. This may be looked upon as the velocity of the nova relative to the sun. The nova is 31° 22′ distant from the point in the heavens toward which the solar system is moving and, if we remove the component due to this motion, we have a velocity of − 2·8 km. per second for the nova with reference to the stellar system, so that we may consider it as approximately at rest with reference to the stellar system.

LINE DISPLACEMENTS ON JUNE 10, 1918

λ	Element	8554 b Vel.	8554 b Wt.	8555 Vel.	8555 Wt.	8556 a Vel.	8556 a Wt.	8556 c Vel.	8556 c Wt.
5018·629	*Fe*	−1432	¼	−1439	½	−1424	½	−1436	½
4924·115	*Fe*	1422	1	1449	½	1399	½	1433	½
4824·33	*Fe-Cr*	1440	¼	1466	¼	1439	¼	1439	¼
4584·018	*Fe*	1424	¼	1451	½	1482	¼	……	……
4572·156	*Ti*	1433	¼	1440	½	1449	¼	1450	¼
4563·939	*Ti*	1454	¼	……	……	1460	¼	1436	¼
4549·766	*Fe-Ti*	1426	½	1434	½	1414	¼	1430	¼
4534·139	*Ti*	1449	¼	1351	¼	1421	¼	1368	¼
4522·871	*Fe*	1481	¼	1479	¼	1466	¼	……	……
4515·508	*Fe*	……	……	……	……	1502	¼	……	……
4508·455	*Fe*	1440	¼	……	……	1415	¼	……	……
4501·448	*Ti*	1420	¼	1411	½	1456	¼	1459	½
4481·400	*Mg*	1450	¾	1433	½	1438	½	1418	½
4443·976	*Ti*	1467	½	1445	½	1457	¼	1458	½
4417·88	*Ti*	1502	¼	1480	¼	……	……	……	……
4404·927	*Fe*	1479	¼	……	……	……	……	……	……
4399·94	*Ti-Cr*	1446	¼	……	……	1451	¼	1455	¼
4395·286	*Ti*	1483	¼	……	……	1466	¼	……	……
4385·55	*Fe*	1501	¼	1494	½	1472	¼	1505	¼
4352·006	*Fe-Mg*	1439	¼	……	……	……	……	……	……
4320·992	*Ti*	1478	¼	1417	¼	1487	¼	1475	¼
4313·034	*Ti*	1344	¼	1384	¼	1387	¼	1389	¼
4308·081	*Fe*	1452	½	……	……	……	……	……	……
4300·211	*Ti*	1403	¼	1405	½	1387	½	1390	½
4294·301	*Ti*	……	……	……	……	……	……	1483	¼
4289·915	*–Ti*	1459	¼	……	……	……	……	……	……
4246·996	*Sc*	1456	½	1469	½	1468	½	1471	¼
4233·328	*Fe*	1451	½	1454	½	1458	½	1466	¼
4226·40	*Ca, Cr, Ti*	1441	¼	1429	½	1430	½	1459	¼
4215·668	*Sr–*	1483	½	1477	½	1500	¼	1482	½
4163·80	*Ti*	1487	¼	1483	½	1476	¼	1476	½
4077·885	*–Sr*	1490	¼	1496	¼	1481	¼	1476	¼
4071·901	*Fe*	1461	¼	1459	¼	……	……	……	……
4063·756	*Fe*	1486	¼	……	……	1498	¼	……	……
4045·975	*Fe*	1510	¼	1484	½	1497	¼	……	……
3933·825	*Ca*	1408	¼	1444	¼	……	……	1473	¼
4861·527	*H*	1374	½	1375	½	1371	½	1373	½
4340·634	*H*	1350	½	1353	½	1345	½	1385	¼
4101·890	*H*	1363	½	1372	½	1378	½	1396	¼
3970·177	*H*	1346	¼	1425	¼	−1432	¼	1379	¼
3889·150	*H*	−1308	¼	−1320	¼	……	……	−1384	¼
Means		−1436·2		−1433·8		−1437·0		−1436·7	
Reduction to Sun		+ 10·3		+ 10·3		+ 10·3		+ 10·3	
Displacement		−1425·9		−1423·5		−1426·7		−1426·4	

Thus, taking the mean of the four, we have a line displacement to the violet on June 10th corresponding to a velocity of 1425·6 km. This represents a displacement at H_β of 23·1 angstroms, at H_γ of 20·6 angstroms, at H_δ of 19·5 angstroms, and at H_ϵ of 18·9 angstroms. I have purposely separated the five hydrogen lines, placing them at the end of the above table, as their displacements seem to be less than those of the metallic lines.

The displacements, relative to the sun, of the metallic lines alone, are respectively 1440, 1436, 1440 and 1437 km., while corresponding figures for the hydrogen lines are 1343, 1358, 1364 and 1370 km., an average difference of 79 km., or more than one angstrom unit. Even allowing for the uncertainty of setting on these broad lines, the discrepancy seems to be real and must have some physical interpretation.

Besides the 41 lines in the above table there were others measured with similar displacements, but being of poorer quality they were not included. With identifications given where possible they are as follows.

λ	Element	λ	Element
5052·2	....	4154·2	....
4588·38	*Cr*	4053·98	*Ti-Fe*
4374·98	*Ti*	4025·29	*Ti*
4221·9	....	4004·6	....
4179·03	*Fe*	3913·61	*Ti*
4173·27	*Ti-Fe*	3910·4	....

The foregoing measurements relate to the set of lines which suffered the least displacement. But as already stated there were in general two sets of lines for those lines appearing on the plates of the preceding evening. The displacements of the other members of the pair are as given in the following table.

λ	Element	8554 b		8555		8556 a		8556 c	
		Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
5018·629..............	*Fe*	−2226	¼	−2191	½	−2235	¼	−2255	½
4924·115..............	*Fe*	2213	½	2183	½	2191	¼	2162	¼
4861·527..............	$H\beta$	2206	¼	2240	½	2223	¼	2240	¼
4481·400..............	*Mg*	2253	¼	2244	½	2265	¼	2190	¼
4340·634..............	$H\gamma$	2225	¼	2188	¼	2206	¼	2146	¼
4101·890..............	$H\delta$	2210	½	2214	¼	−2225	¼	2210	¼
3970·177..............	$H\epsilon$	2211	½	−2221	¼	....	......	2213	¼
3933·825..............	*Ca*	−2222	¼	....	......	....	......	−2206	¼
Means..............................		−2218·2		−2212·6		−2224·2		−2208·4	
Reduction to Sun..................		+ 10·3		+ 10·3		+ 10·3		+ 10·3	
Displacement......................		−2207·9		−2202·3		−2213·9		−2198·1	

The mean of these four displacements, − 2205·6, corresponds to a shift to the violet at H_β of 35·8 angstroms, at H_γ of 31·9 angstroms, at H_δ of 30·2 angstroms, and at H_ϵ of 29·2 angstroms.

SUMMARY OF ABSORPTION LINE DISPLACEMENTS

Plate	Date, G.M.T.	Series 1		Series 2		Calcium *H* and *K*	
		Vel.	*n*	Vel.	*n*	Vel.	Wt.
	1918						
8543	June 9·668	−1266	8			−23·2	1¼
8545	" 9·681	1267	6				
8546	" 9·683	1239	6			26·4	¾
8549	" 9·722	1288	6			14·8	¾
8550	" 9·815	1237	4				
8551	" 9·832	1240	8			24·2	1
8551	" 9·836	1239	7			21·8	1
8554	" 10·674	1426	39	−2208	8	12·1	2¼
8555	" 10·681	1424	30	2202	7	23·9	1½
8556	" 10·691	1427	32	2214	6	23·8	1
8556	" 10·700	1426	28	2198	8	17·2	1¾
8559	" 13·723	1588	12	2308	4	13·3	1
8561	" 13·756	1588	15	2360	3	21·7	2
8572	" 14·711	1663	7	2368	4	23·3	1¼
8568	" 15·711	1682	8	−2281	4	21·2	1
8575	" 17·666	1735	5			15·5	1½
8585	" 18·810	1728	4			15·5	1¾
8588	" 19·734	1746	5			22·7	1¼
8589	" 20·595	1739	2				
8590	" 20·642	1739	3				
8596	" 25·734	1760	4			19·2	1½
8603	July 2·661	1671	3			24·2	1½
8605	" 3·670	1667	3			−25·0	¾
8607	" 4·618	1679	3				
8609	" 5·694	1667	3				
8612	" 9·710	1682	1				
8618	" 13·723	1688	2				
8619	" 14·645	1693	2				
8620	" 15·652	1687	2				
8621	" 17·630	1695	2				
8623	" 18·597	1688	1				
8624	" 18·644	−1705	1				

MEASURES OF NOVA AQUILÆ NO. 3

λ	8543		8546		8545		8549 a		8550 b		8551 a		8551 b	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
5018·629	−1298	¼	−1211	¼	−1275	¼	−1285	¼			−1224	¼	−1235	¼
4924·115	1302	½	1232	¼	1255	¼	1322	½	−1168	⅛	1273	¼	1253	¼
4861·527	1307	¼	1308	½	1311	½	1317	½	1296	½	1296	½	1239	½
4340·634	1296	½	1214	½	1279	¼	1290	½	1231	½	1244	½	1238	½
4101·890	1247	½	1229	½	1264	½	1285	½	−1220	¼	1206	¼	1246	½
3970·177	1257	¼	−1300	¼			−1257	⅛			1264	½	1244	¼
3933·825	1269	¼			−1267	¼					1264	¼	−1319	¼
3889·150	−1178	⅛									−1176	¼		
Weighted mean	−1277·10		−1249·48		−1276·99		−1250·30		−1247·13		−1250·10		−1249·70	
V_a	+ 10·95		+ 10·95		+ 10·95		+ 10·95		+ 10·95		+ 10·95		+ 10·95	
V_d	+ 0·19		+ 0·17		+ 0·17		+ 0·11		− 0·09		− 0·13		− 0·13	
Curv.	− 0·28		− 0·28		− 0·28		− 0·28		− 0·43		− 0·28		− 0·28	
Radial Velocity	−1266·2		−1238·6		−1266·1		−1239·5		−1236·7		−1239·7		−1239·3	

λ	8559 b		8561 a		8572 b		8568 a		8575 a		8585		8588	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
5018·629	−1597	½	−1619	¾			−1685	¼						
4924·115	1597	½	1575	¾			1670	½						
4861·527			1615	¼			1754	¼						
4584·018	1614	¼	1617	¼			1697	¼	−1707	¼	−1741	¼		
4549·766	1577	¼	1645	½										
4481·400	1583	¼	1597	½	−1719	¼								
4468·663	1584	¼	1582	½	1638	½								
4443·976	1583	¼	1586	¼	1661	¼								
4340·634	1605	½	1579	¾	1700	½	1703	¼	1766	½	1735	1	−1763	1
4300·211			1493	¼										
4294·301			1638	½										
4289·915			1579	½										
4233·328	1595	½	1604	½	1645	¼	1671	¼					1718	½
4163·80 –	1597	¼	1575	¼										
4101·890	1595	½	−1604	½	1669	½	1675	½	1746	¾	1743	1	1760	1
3970·177	−1623	¼			−1705	½	−1704	¼	1755	½			1776	½
3933·825									−1722	½	−1715	½	−1723	½
Weighted mean	−1597·00		−1596·87		−1671·27		−1690·40		−1733·10		−1735·02		−1751·86	
V_a	+ 9·22		+ 9·22		+ 8·80		+ 8·38		+ 7·96		+ 7·30		+ 6·64	
V_d	+ 0·03		0·00		+ 0·10		+ 0·10		+ 0·16		− 0·12		+ 0·03	
Curv.	− 0·43		− 0·43		− 0·43		− 0·43		− 0·28		− 0·28		− 0·28	
Radial Velocity	−1588·2		−1588·1		−1662·8		−1682·4		−1725·4		−1728·3		−1745·6	

MEASURES OF NOVA AQUILÆ NO. 3—*Continued*

λ	8589		8590		8596		8603		8605		8607		8609	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	....	....	....	....	−1786	¼	....	....	....	....	....	....	....	....
4340·634	−1727	½	−1734	½	1762	¾	−1678·9	1	−1662·5	1	−1673·4	1	−1663·2	1
4101·890	−1763	½	1741	¾	1764	1	1667·6	1	1675·1	1	1676·5	1¼	1670·3	1½
3970·177	....	....	−1775	¼	−1756	¾	−1669·0	1	−1663·7	1	−1688·2	¾	−1663·7	1
Weighted mean	−1745·00		−1744·40		−1763·27		−1671·83		−1667·10		−1678·39		−1666·09	
V_a	+6·00		+6·00		+3·95		+0·81		+0·37		−0·08		−0·53	
V_d	+0·23		+0·19		0·00		+0·11		+0·09		+0·16		+0·02	
Curv.	−0·28		−0·28		−0·28		−0·28		−0·28		−0·28		−0·28	
Radial Velocity	−1739·2		−1738·6		−1759·6		−1671·2		−1666·9		−1678·6		−1666·9	

λ	8612		8618		8619		8620		8621		8623		8624	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4340·634	....	....	−1680·9	½	−1689·4	¾	−1677·7	¾	−1684·2	¾	....	....	....	....
4101·890	−1678·8	1	−1684·3	1	−1688·0	1	−1684·4	1	−1693·1	¾	−1681·4	½	−1698·4	½
Weighted mean	−1678·80		−1683·17		−1688·60		−1681·30		−1688·65		−1681·40		−1698·40	
V_a	−2·39		−4·15		−4·61		−5·06		−5·96		−6·38		−6·38	
V_d	−0·02		−0·09		+0·07		+0·06		+0·09		+0·14		+0·04	
Curv.	−0·28		−0·28		−0·28		−0·28		−0·28		−0·28		−0·28	
Radial Velocity	−1681·6		−1687·7		−1693·4		−1686·6		−1694·8		−1687·9		−1705·0	

λ	8559 b		8561 a		8572 b		8568 a							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	−2420	½	−2459	¾	−2462	½	−2281	¾	....	....	....	....	....	....
4340·634	2448	¼	2450	½	2329	½	2280	¾	....	....	....	....	....	....
4101·890	2229	½	−2230	¾	2335	¼	2295	¾	....	....	....	....	....	....
3970·177	−2234	½	....	....	−2342	¼	−2307	½	....	....	....	....	....	....
Weighted mean	−2316·30		−2369·30		−2376·53		−2289·25		....		....		....	
V_a	+9·22		+9·22		+8·80		+8·38		....		....		....	
V_d	+0·03		0·00		+0·10		+0·10		....		....		....	
Curv.	−0·43		−0·43		−0·43		−0·43		....		....		....	
Radial Velocity	−2307·5		−2360·5		−2368·0		−2281·2		....		....		....	

DETAILED DISCUSSION OF THE SPECTRUM OF NOVA AQUILÆ NO. 3

In addition to the main features of the spectrum, already discussed in the preliminary general statement, there were many less conspicuous but important details shown in the plates, and striking changes took place throughout the spectrum from time to time. These details and changes are dealt with in the following description of the spectrum as secured here from day to day.

June 9th.—The plates showed a fairly strong continuous spectrum with absorption bands about 8 angstroms wide, which were none too well contrasted. Besides the hydrogen series there were the *H* and *K* lines of calcium, the presence of the former line being fairly certain from the complex character of the line as combined with H_ϵ. Then there were other bands, in general much fainter than the hydrogen, having the following wave-lengths, λλ 5018, 4924, 4584, 4549, 4481, 4300, 4233 and 4163. All these bands were displaced from their normal positions to the violet by an amount corresponding to a velocity of approach of 1250 km. per second. As previously stated, this does not imply a translation of the star or of its vapours at this rate, but is only a ready method of expressing the displacement of the lines from their normal positions. The agreement among the different lines was all and even better than what could be hoped for, and revealed that in this nova, as in previous ones, the displacement of the lines was proportional to the wave-length. Besides the broad calcium bands there were also sharp *H* and *K* lines very slightly displaced from their normal positions towards the violet. While the broad bands shifted their positions from time to time, these latter well-defined lines have maintained a constant position which, as may be seen from an accompanying table, is of the order of 20 km. per second approach; that is, a displacement of about one-third angstrom to the violet of their normal positions. Nothing definite in the nature of emission can be seen on the plates taken throughout the night.

June 10th.—The first plate taken on this evening showed a decided change in the spectrum. Emission bands, particularly of hydrogen had now made their appearance, flanked on the side of greater refrangibility by pairs of absorption lines. The continuous spectrum is quite strong, yet there would seem to be no uncertainty in regard to the presence of the emission bands, even though they are not pronounced as yet. It is quite a task in a spectrum where both emission and absorption bands are present, as in this case, to properly interpret what one sees on the plate, and different persons might read quite different results from the same plate. In some cases weight may be given to the interpretation of the absorption lines as being simply spaces between the emission bands, but it seems to me in the case of Nova Aquilæ No. 3, on this date we have genuine absorption taking place. The appearance on this date is that of a strong continuous spectrum crossed by a great many absorption bands, and in addition having broad emission bands of hydrogen and possibly a few other substances. These absorption bands have been identified as due to hydrogen, magnesium, calcium and enhanced lines of iron, titanium and other substances, as indicated in one of the accompanying tables. Pairs of absorption lines, as mentioned just now, occur at the violet edges of the hydrogen emission, and also for wave-lengths, λλ 5018, 4924, and 4481, the least refrangible of the pair—the one corresponding to that of the previous evening—being always the more intense of the two. Measurements upon the most suitable 30 or 40 out of the total 70 odd, that can be counted between λ 3889 and λ 5018, show a displacement from their normal positions equivalent to a velocity of approach of 1426 km. per second. The corresponding displacement for the other members of the pair, about 8 or 9 in number, is for this night 2206 km. per second, as shown in the summary of measures.

June 13th.—The emission bands have become strengthened relative to the continuous spectrum. The numerous absorption lines seen on the 10th are missing; only those visible on the 9th remaining. All lines have shifted more to the violet, the displacements being represented by velocities of −1588 and −2360 km. respectively. The emission bands are not uniformly intense throughout their breadth, but appear as if annulled in several places by absorption lines. The more refrangible of the lines at λ 5018 and λ 4924 and apparently λ 4481 also are missing, while the corresponding one for H_β has become broadened and much intensified, with a corresponding decrease in intensity in the other member of the pair. The other hydrogen lines show a tendency to shift the intensity from the red to the violet member of the pair, though the effect is not so marked as in H_β.

June 14th.—The phenomena of the previous evening of the emission being "eaten out" in places by absorption is accentuated on plates of this date. There results the appearance of three distinct divisions to each of the hydrogen bands, the main one being some 10 or 15 angstroms wide at about the normal position of the line, the others less than half as broad, and centred roughly some 1200 or 1300 km., respectively, to the red and violet of the normal positions. Numerous other emission bands are without doubt present, there being a pair around λ 4625 and λ 4640, while from λ 4584 to λ 4501 there are several emission bands. Fewer definite absorption lines are seen than on the previous evening, and their displacements correspond to a negative velocity of 1663 km., while the second member of the hydrogen pair is about 2368 negative.

June 15th.—The emission and continuous spectrum is quite similar to that of the preceding evening, while the absorption lines have become fewer in number, being confined principally to the pairs of hydrogen lines; the enhanced lines, λλ 5018, 4924, 4584, 4233 and the calcium *K*.

June 17th.—There is considerable of a change on this date. The emission bands of hydrogen are much more uniform in intensity throughout their width. The change seems to have been gradual, as those of the 15th are slightly more uniform than those of the 14th. H_β extends from λ 4833 to λ 4889; H_γ from λ 4317 to λ 4364; H_δ from λ 4079 to λ 4122; H_ϵ from λ 3948 to λ 3990, so that the centres of the emission bands are in the normal positions of the lines and their width varies approximately with the wave-length. The emission is sharply terminated at the violet edge by the absorption line. The main difference to the preceding plates is the absence of the more refrangible of the pair of absorption lines which terminated the hydrogen emission bands on the violet, and which first appeared on the night of the 10th. Further, a new absorption band is beginning to show itself about λ 4060, with a tendency to have centres of intensity at λ 4056·7 and λ 4065·7. If these have suffered displacement like the other absorption lines, their normal values would be about λ 4081 and λ 4090.

June 18th.—Quite similar to the 17th. When the characteristic pairs of absorption lines occurred on the 10th there was slight absorption to the violet of the pair at λ 5018, which was not present on the preceding night. This has been steadily increasing in intensity and, being some 50 angstroms wide, is quite a noticeable feature of the spectrum at this phase. Its centre is at λ 4959·5 the position of N_2.

June 19th.—A pair of absorption lines to the violet of the 4640 band with centres at λ 4607 and λ 4595 are more definite, otherwise little change from the preceding night.

June 20th.—A further strengthening of intensity in the pair of absorption lines λ 4607 and λ 4595 and a decrease of the continuous spectrum relative to the emission are shown. The emission band at λ 4640, which could be detected as a strengthening of the continuous spectrum on the 13th, has gradually become stronger until now it is quite marked.

June 23rd.—The broad emission bands of hydrogen with an absorption line to the violet of each and with the additional very broad but not so intense emission at λ 4640 without absorption to the violet is what we find in spectra of this date. The continuous spectrum is weak. H_β has an absorption at the red edge of its emission. The appearance is as if emission was centrally superposed on a somewhat broader absorption. Instead of λ 4057 and λ 4066 which appeared on the 17th, though suspected on the 15th, there are two quite strong bands at λ 4059·4 and λ 4054·3, the former and λ 4057 perhaps being one and the same band.

June 25th.—Somewhat similar to the 23rd, though the continuous spectrum is more intense and the λ 4640 emission relatively much fainter than on that date. Rough estimates of the relative intensities of the continuous spectrum to H_δ, H_γ and H_β are as 1 to 5 to 10 to 25. Quite definite centres of intensity appear at λ 4055 and λ 4060.

June 26th.—The continuous spectrum is weak and the absorption lines which terminated the violet edges of emissions are now lost. The emission bands at λ 4640 and those due to hydrogen have the appearance of being double, owing to their centres being "eaten out" by absorption whose width is about one-half their own. Additional emission bands 5 or 10 angstroms wide are seen at λλ 4584, 4530, 4490, 4450, 4434, 4395, 4302 and 4252. Absorption extends from λ 4062 to λ 4075 without any particular centre of intensity.

June 28th.—The plate is too weak for definite study, but the emission bands appear to be the same as on the 26th. The centres of intensity for the λ 4640 emission are at λ 4618 and λ 4658.

June 29th.—Again the appearance of centrally superposed absorption bands on broader emission. Faint emission extends approximately from λ 5030 to λ 4980 with absorption cutting out the centre, leaving strips of emission about 8 or 10 angstroms wide whose centres are at λ 5024 and λ 4984. Strong H_β emission extends from λ 4888 to λ 4834, eaten out by centrally placed absorption about half the width of emission. The red portion of the emission is the more intense. Faint emission extends from λ 4710 to λ 4666, then emission as strong as H_β from there to λ 4614, whose central portion suffers partial absorption, leaving strong centres of emission at λ 4658 and λ 4622. Similar emission strips are seen in the region λ 4584 to λ 4382, as on the 26th. H_γ emission extends from λ 4364 to λ 4316, with central absorption, the red portion of the remaining emission centred at λ 4359 being more intense than the corresponding violet portion, just as was the case with H_β. H_δ extends from λ 4124 to λ 4075, with absorption and other features similar to H_β and H_γ. H_ϵ is much fainter, but seems similar to others. In general, the emission bands are 50 angstroms wide and decrease in intensity with decreasing wave-length.

July 2nd.—The continuous spectrum has again become strong and with its increased intensity the absorption line, which formerly terminated the violet edges of the hydrogen emissions, again reappears, this time as a close double in H_γ, H_δ and H_ϵ. The emission band at λ 4640 has its intensity relative to the hydrogen bands diminished to a considerable degree, the appearance being more of a strengthening of the continuous spectrum in that region. Rather indefinite centres of intensity are seen at λ 4053 and λ 4060 for that particular absorption band. The star has, of course, brightened up since the last observation.

July 3rd.—The absorption pair terminating H_γ, H_δ and H_ϵ is more pronounced than on the preceding evening. Expressed in velocities they are − 1667 km., and − 1802 km.

July 4th.—In general similar to preceding.

July 5th, 6th.—The more refrangible of the pair of absorption lines seen on the 2nd, 3rd and 4th is now missing. The λ 4060 band has a tendency to show centres of intensity at λ 4057 and λ 4062.

July 9th.—Emission becoming the predominant feature, that at λ 5007 regaining in intensity relatively to the others. The only absorption line seen bordering the hydrogen emissions is that at H_δ. Absorption occurs at λλ 4573, 4555, 4500, 4445, and a narrow pair at 4422, 4421, and faint absorption at λ 4109. There is also a pronounced absorption line near λ 4096. Its position is identical with those measured as hydrogen lines from July 19th to November 10th. This seems to be a transition date.

July 10th, 11th, 12th.—Emission similar to the 9th. H_δ and λ 4096 absorption absent. The spectra of these dates is somewhat similar to that of June 29th, when the star was about the same magnitude. In the interval, it increased in brightness probably 0·7 magnitude and has diminished again by the same amount. There are some differences, and a fuller description is in order. There are six prominent emission bands, H_β, H_γ, H_δ and λ 4640, and of lesser intensity λ 5007 and H_ϵ. These have the appearance of being superposed on absorption bands greater in width by 20 to 40 angstroms. Emission extends from λ 4671 to λ 4606, and shows a tendency to resolve into two parts. Moreover, while it fades off gradually into the continuous spectrum at its violet edge it would apparently continue some 40 angstroms further to the red were it not for absorption which cuts into it, leaving two disjointed strips of emission. Similar faint emissions are seen at λλ 4584, 4549, 4529, 4491 and a strip from λ 4466 to λ 4445 terminated by an absorption band or series of absorption lines. The extreme limits of H_γ and the nebular λ 4363 emissions are from λ 4316 to λ 4385 and are fairly well defined. The strong portion is from λ 4335 to λ 4363, but this itself is eaten into centrally by absorption lines. H_δ and H_ϵ have the usual limits. Thus the emission bands of hydrogen, their widths 40 to 50 angstroms and roughly proportional to their wave-lengths, continue to be near the normal positions of the lines.

July 13th, 14th, 15th.—Differs from preceding in that sharp H_γ and H_δ absorption lines are seen to the violet of the emissions.

July 17th.—Continuous spectrum stronger. A decided pair of absorption lines at λ 4051·3 and λ 4057·9. Broad absorption lines have appeared gradually of late at λ 4572 and λ 4554. The star for the last few evenings has been 2 or 3 tenths of a magnitude brighter than it was one week ago.

July 18th.—The line λ 4051 of the preceding night is faint, while λ 4058 is missing entirely. If H_γ absorption is present it is very faint and diffuse.

July 19th.—Continuous spectrum decidedly weaker. There are indications of the λ 4051 and λ 4058, but none of the λ 4554 and λ 4572, though the continuous spectrum is of sufficient intensity to reveal them. The absorption lines to the violet of the hydrogen emissions are missing entirely.

July 20th.—There is stronger absorption from λ 4575 to λ 4549 and emission at λ 4584 and λ 4528, which does not show on the plate of the preceding night.

July 21st.—Continuous spectrum weakened and emission less uniform as absorption has eaten into their centres. The spectrum of this date is a replica of June 26th, with the addition of the nebular emission λ 4363, which joins on to H_γ, and extends to λ 4385.

July 24th, 25th, 26th.—The main emission at H_β is some 50 angstroms wide "eaten out" centrally by absorption. Emission reversal 10 angstroms wide is centred at the normal position of the line. All emission is more uniform, otherwise general features as on the 21st.

July 30th and 31st.—The nebular emissions at λ 5007, λ 4363, are about equally bright with H_γ and only slightly less so than H_β. Emission is even more uniform than immediately preceding dates.

August 1st.—Identical with spectrum of July 21st. Approaching minimum in both cases.

August 23rd, 24th, 25th, 26th, 27th, 29th;
September 7th, 21st, 22nd, 30th;
October 3rd, 8th, 21st;
November 2nd, 10th.—The plates of these dates are quite similar in general, and consist principally of emission bands as given in the following table. Since about the 21st of July the continuous spectrum has pretty well vanished and what changes have taken place are details within the emission. The nebular emissions, N_1 (λ 5007) and N_2 (λ 4959) have on the whole strengthened during the interval. The tendency has been for the absorption within the emissions to show itself more as definite lines.

SUMMARY—EMISSION SPECTRUM—JULY 19 TO NOVEMBER 10

	Red Edge	Violet Edge	Centre
Faint emission	5033·7	5014·0	
Strong emission N_1	5014·0	5000·4	5007·2
Faint emission	5000·4	4977·7	
Faint emission N_2	4966·0	4952·5	4959·2
$H\beta$ emission	4887·6	4833·4	4860·5 ± 0·03
Faint emission	4710·9	4679·	
Strong emission	4668·8	4612·4	4640·6
Faint emission } λ 4363	4387·2	4368·	
Strong emission } and	4363·3	4336·7	
Faint emission } $H\gamma$	4336·7	4315·8	
$H\delta$ emission	4123·2	4075·5	4099·8

The foregoing limits were computed from measures made upon the plates, using the Hartmann interpolation formula. Naturally more or less error exists in the measures, as some of the edges are not well defined. H_δ while fairly definite at the red edge, is not so at the violet and towards the close of the interval stated the entire emission there becomes quite weak. $H\gamma$ cannot be dissociated from the nebular 4363 emission. At times an increased intensity is shown at λ 4370 to λ 4358 as if due to overlapping. A similar case exists with the 4640 band, though on July 21st and August 1st the two emissions are definitely separated with centres at λ 4612 and λ 4659. The N_1, N_2 and H_β emissions are fairly well defined, however. With H_β the greatest range in the measures for either limit is 1·8 angstroms with a probable error for the mean of 24 plates of less than 0·1 angstrom, and it would seem that the displacement to the violet of 1 angstrom cannot wholly be accounted for by error of measurement. It should be stated that its centre for the period, June 17 to July 17 inclusive, was 0·4 angstroms to the violet but the limits were not nearly so definitely determined. Correction of course has been made for the 20 km. velocity of approach. H_δ is in the same direction 2 angstroms, but its centre likewise cannot be so definitely established.

Besides the absorption lines, hereafter spoken of as the hydrogen lines from the fact that their displacements from their normal positions are proportional to their wavelengths, the following are measured on the majority of the plates in this interval. A band 12 angstroms wide centred at λ 4971·8 is also a feature which intensifies as time proceeds.

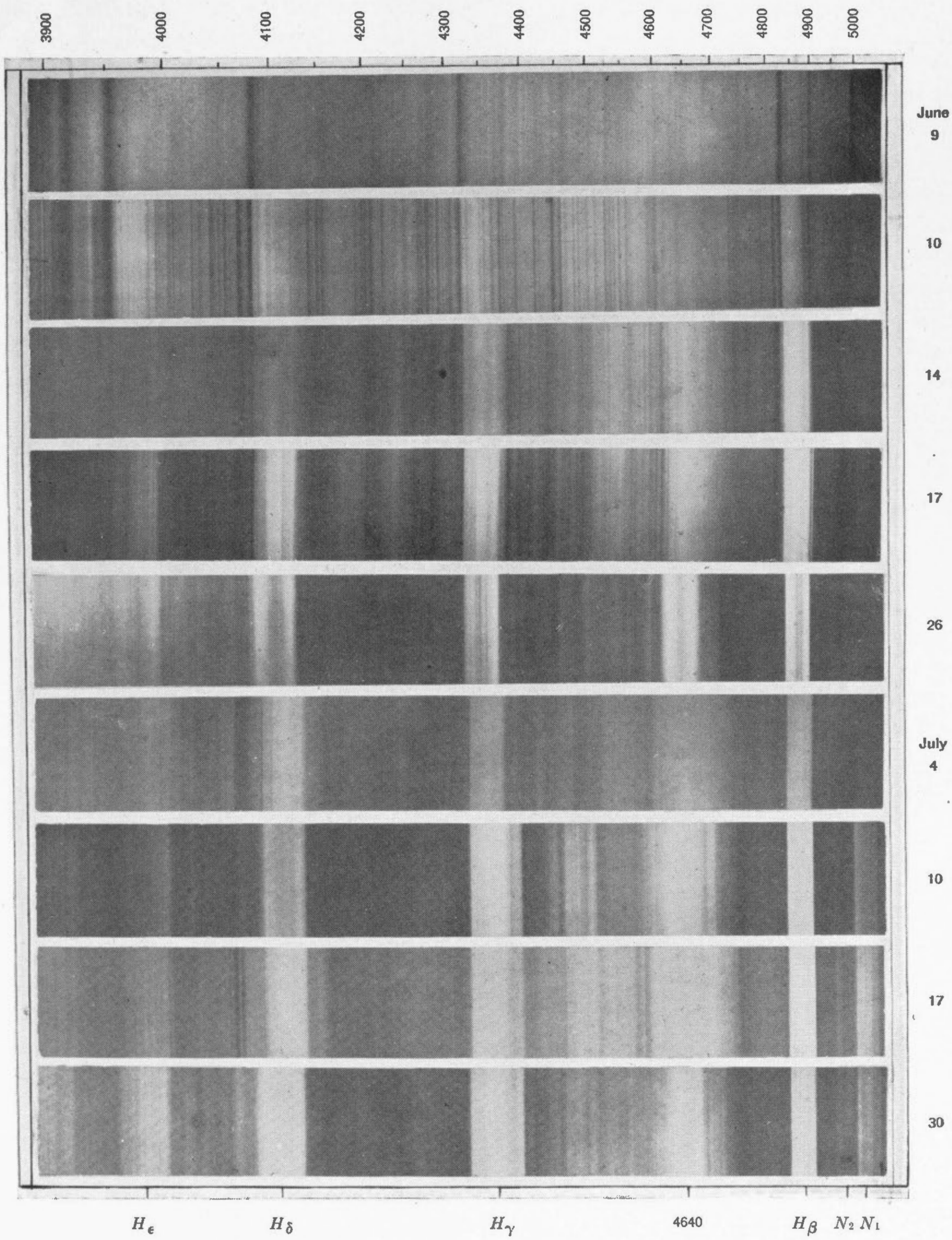
ABSORPTION LINES

5017·0	4383·4	4127·2
4951·6	4372·0	4125·1
4633·5	4357·2	4120·0
4612·3	4337·5	4115·8

Absorption lines were always present some 6 or 7 angstroms to the violet of H_β, H_γ and H_δ during the interval quoted, and became increasingly better defined as time proceeded. On the assumption that they are due to hydrogen, their displacements—using the velocity idea—are as given in the following table. The agreement among themselves was all that could be desired.

DISPLACEMENTS HYDROGEN ABSORPTION LINES

Date	Velocity	Weight	Date	Velocity	Weight
1918			1918		
July 19	−455	¾	Aug. 26	−443	1¾
" 20	453	¾	" 27	444	1½
" 21	448	¾	" 29	451	1½
" 24	450	½	Sept. 7	442	1½
" 25	456	1	" 21	462	½
" 26	443	1	" 22	447	1½
" 30	439	1¼	" 30	446	1
" 31	445	¾	Oct. 3	440	1
Aug. 1	442	1	" 8	449	1¼
" 23	443	2¼	" 21	447	1
" 24	434	1¼	Nov. 2	444	¾
" 25	−449	1¼	" 10	−444	1½



Spectrum of Nova Aquilæ No. 3

66701

Enlarged 3·9 times in length and 37 times in width

The mean is $-446 \cdot 0$ corresponding to a displacement at H_γ of $6 \cdot 5$ angstroms with corresponding values for H_β and H_δ.

The spectra shown are from the original negatives enlarged lengthwise three and nine tenths times and thirty-seven fold in width. They show the most characteristic types. The first two illustrate the rapid change that took place in the 16 hours or so between observations late on the 9th and early on the 10th, and makes one sceptical of a stellar classification in which we are led to think of millions of years being required for a star to pass from one type to another.

To discuss fully the probable causes of the origin of new stars and the various theories that have been put forward from time to time to explain them would be out of place in an article already lengthy. It may be permitted to make some comparisons, however, between this nova and other striking ones, particularly Nova Aurigæ (1892), Nova Persei (1901) and Nova Geminorum (1912) and to point out wherein some of the theories fail to satisfy the observed facts.

(1) The region of the sky in which it occurred is noteworthy. Apart from the numerous faint novæ found recently in spiral nebulæ they are all situated in the plane of the Milky Way, where matter is more plentiful and where collisions would be more likely to occur than elsewhere.

(2) This was a known star and it required at least three days to increase to its maximum light. This would discredit the theory, adopted many years ago to account for new stars, of a collision occurring between two practically dead worlds, for according to that theory a few hours would suffice for the bodies to cut through each other with the tremendous velocities they were assumed to possess. The Director, Dr. Otto Klotz, has made the suggestion that since this was a known star if a change in proper motion can be shown to have taken place in the star after the outburst, then some weight would be lent to the collision theory. It is doubtful, however, if the previous observations were of sufficient precision to definitely settle the matter.

(3) If we accept the measures of the sharp H and K lines of calcium, which are presumably reversals, as representing the radial motion of the star then the three novæ,—Persei, Geminorum and this one—in which these lines have been well measurable, have radial velocities which are approximately zero with reference to the stellar system.

(4) The strong continuous spectrum before maximum light was reached, while possibly accounted for by high pressures, would more reasonably suggest that some internal cause was heating up the core of the star. On the other hand, the rapid diminution in light after it had reached its maximum would argue for superficial disturbances as would also the fact that the continuous spectrum rapidly faded and was replaced by one of a nebular type, noticeable after a week and quite strong in a month's time.

(5) The history of the star, since it was first photographed 30 years ago, shows it to have been varying in light over two magnitudes, and this might incline us to the idea that the causes operating in variable stars were present here also. Then the similarity of the oscillations, which took place in the light of the star during July and August, to those occurring in Cepheid variables in which the time from minimum to maximum is shorter than from maximum to minimum should be noted, though the point should not be strained too far. It may be added, that all the better observed novæ show these oscillations in brightness.

(6) The greater the outburst, the greater the widths of the emission lines and the greater the displacements of the absorption lines. Tabulating the four novæ in order of maximum brightness we have:

Nova	Mag.	Width Em.	Dispt. Absorption
Aurigæ	4·7	15 A	−700 km. per sec.
Geminorum	4·0	24 "	−850 " "
Persei	0·5	33 "	−1100 to −1500 " "
Aquilæ	−1·5	47 "	−1250 to −1750 " "

The collision theory was adopted in the case of Nova Aurigæ by several, among whom was Vogel, who afterwards discarded it in favour of the idea, that alternate layers in the star's atmosphere gave rise to bright and dark bands and that owing to pressure the emission bands were slightly displaced to the red from their normal positions, thereby leaving uncovered at their violet edges portions of the absorption bands. This conclusion was based upon Wilsing's work on the pressure effects on gases, and more particularly upon the earlier and more comprehensive work of Jewell, Humphreys and Mohler. This explanation will not suffice in the present instance, for in addition to the hydrogen lines, which appear as both emission and absorption, we have numerous metallic lines which appear as absorption only, and yet suffer displacements similar to those of hydrogen.

Seeliger's theory of a main body approaching the sun and running into a cosmic cloud, and Lockyer's idea of the meeting of not one but two cosmic streams, one denser than the other, both have some resemblance to the popularly accepted theory of a body approaching the inert stage and in its motion through space becoming enmeshed in a nebula.

The explosive theory was put forward by W. H. Pickering, and in view of our recent knowledge regarding the pent up energy in radio-active substances is not without merit, particularly if we assume, as did Huggins, that the close approach of the two bodies caused them to become more and more distorted and elongated until finally the great outburst occurred. Pickering's latest idea is that of a meteor plunging into a so-called dead world.

The earlier novæ all showed displacements of the emission bands towards the red, which in the case of Aurigæ amounted to about 6 angstroms, and these bright bands were assumed to belong to the receding star. When other novæ likewise showed redward displacements the case was weakened, for why should not novæ be found in which the bright-line star was approaching and not receding? The displacements of the emissions were in the same direction in Geminorum and Persei, but they were much smaller in amount, and in Nova Aquilæ the displacement was if anything to the violet.

When our knowledge of the laboratory behaviour of gases under varying conditions of pressure and temperature—not overlooking anomalous dispersion phenomena—is more complete, we will be in a better position to theorize regarding the origin of new stars. A hopeful sign lies in the fact, that spectra of some nebulæ show remarkable resemblance to those of novæ. Slipher secured a spectrogram of Hubble's variable nebula requiring 37 hours exposure, which shows numerous bands and lines that were present in certain stages of former novæ. In the meantime, we are glad that the present nova has given opportunity to learn a few additional facts regarding these interesting objects.

Dominion Observatory
Ottawa
December, 1918.

Note added while going through the press.

A spectrogram taken, 1919, March 13·92, shows the nebular emissions $\lambda\lambda$ 5007·2. 4959·2 and 4362± in this order of intensity; the two former having well-defined limits and being about 12 angstroms wide, while λ 4362 was about 50 angstroms wide with ill-defined limits.

PUBLICATIONS
OF THE
DOMINION OBSERVATORY
OTTAWA, CANADA
Vol. IV, No. 19

ν GEMINORUM, A LONG PERIOD BINARY

BY W. E. HARPER, M.A.

(1900, $\alpha = 6^h\ 23^m.0$, $\delta = +20° 17'$, mag. 4.06, type B5)

This star was announced as a spectroscopic binary by Lee in the *Astrophysical Journal*, volume XXXII, page 301, from 5 plates taken in the years 1901 to 1909 which showed a range of 27 km., and whose measures are given in the accompanying table. It was noted that the *H* and *K* lines of calcium gave velocities different to the other lines.

A series of plates were made here during the years 1910, 1911, 1912, 1913 and 1914, 52 of these plates were measured by Mr. T. H. Parker without giving any clue to the period. When Mr. Parker responded to a higher call and went overseas, the star was taken over by the writer and plates have been made from time to time, so that now we have 83 altogether. While Mr. Parker's measures were felt to be just as reliable as any that could be made upon the plates, yet, owing to the complex character of the lines and the possibility of different interpretations being placed upon them, it was thought better for the writer to measure all the plates and thereby possibly secure greater homogeneity.

While the helium lines λ 4471 and λ 4026 can be detected on most of our plates, they are, with possibly the exception of one plate, entirely too faint to be measured and consequently the results depend upon the four hydrogen lines H_β, H_γ, H_δ, and H_ϵ. H_ϵ is only rarely used, H_γ is by far the most dependable line with H_δ next in order and then H_β. The numbers 9, 4 and 3 would express the relative weights of these three. The measures of the calcium line *K* have been kept separate as Lee's discovery of its distinct character has been verified, even though the line lacks contrast and is of extremely poor quality for measurement. While the extreme variation shown for measures of this line is in the neighbourhood of 50 km., yet this range is only shown where the line is very poor and the measurement uncertain and it is not likely that the real range is much over half this amount. There does not seem to be any progressive variation over a long period, as is the case for the hydrogen lines; the velocities for each year average up about the same. The weighted mean velocity for the line on 33 plates is + 16.9 km. per second, while that of the center of the system is in the neighbourhood of + 38 km. per second.

That there is a short-period oscillation in the velocities would seem to be without doubt, but a satisfactory period has not as yet been obtained. As the range in velocity of this short-period variation is small, it has been possible by combining the velocities for each season into one mean to detect a long-period variation. There are, unfortunately, a few gaps yet to be filled in, but there seems no doubt of the general trend of the velocities over a curve whose period is about 9·6 years. The Yerkes' plates and our own are used in the table of measures and in the grouped velocities following. To clear of fractions the weights assigned to plates are 8 times the total weight of the lines on the plates.

OBSERVATIONS OF ν GEMINORUM

Plate	Date	Julian Date	Vel. *H* lines	Wt.	Vel. Calcium	Wt.
	1903					
Yerkes	Dec. 1	2,416,450·953	+24·0		− 6	
"	" 25	6,474·945	33·0		+ 1	
	1906					
"	Feb. 26	7,268·742	6·0		+22	
	1908					
"	Jan. 24	7,965·727	15·0		+12	
	1909					
"	Jan. 1	8,308·777	20·0			
	1910					
3743	Oct. 12	8,957·932	97·6	5	− 4	1
3795	Nov. 2	8,978·910	59·6	8		
3824	Dec. 5	9,011·944	62·9	6	+28	1
3848	" 9	9,015·874	78·8	7	+28	1
3882	" 16	9,022·816	75·7	4	+39	1
3892	" 21	9,027·834	81·6	8	+16	2
3910	" 30	9,036·827	48·4	4		
	1911					
3924	Jan. 9	9,046·715	52·0	6		
3941	" 16	9,053·852	40·9	6	+ 4	2
3950	" 17	9,054·832	49·2	4	+21	1
3975	" 30	9,067·705	94·3	12	+ 8	1
3997	Feb. 15	9,083·730	73·2	6		
4008	" 22	9,090·714	58·4	4	+ 7	1
4021	" 27	9,095·625	61·1	7	+ 4	1
4059	Mar. 6	9,102·670	42·3	4		
4069	" 7	9,103·628	63·7	10		
4088	" 10	9,106·593	74·3	9	+19	4
4101	" 13	9,109·612	71·4	6		
4115	" 14	9,110·614	70·4	10	+27	4
4119	" 16	9,112·614	72·9	6	+31	1
4133	" 20	9,116·583	73·6	13		
4136	" 24	9,120·593	76·2	16	+ 8	4
4638	Oct. 12	9,322·924	66·5	10	+34	1
4698	Nov. 16	9,357·911	55·9	8	+24	4
4710	Dec. 3	9,374·903	72·3	7		
4719	" 6	9,377·850	60·8	10		
4732	" 19	9,390·718	63·4	10	+18	2
4740	" 25	9,396·784	74·5	12		
	1912					
4752	Jan. 7	9,409·763	68·2	7		
4763	" 10	9,412·753	57·8	9		
4782	" 12	9,414·776	69·3	12	+ 5	1
4794	" 16	9,418·729	63·8	10		
4803	" 19	9,421·740	+72·8	16	+31	1

OBSERVATIONS OF ν GEMINORUM—*Concluded*

Plate	Date	Julian Date	Vel. *H* lines	Wt.	Vel. Calcium	Wt.
	1912					
4813	Jan. 25	2,419,427·763	+52·6	10	+36	1
4821	" 26	9,428·734	25·5	8	+11	1
4836	Feb. 12	9,445·690	72·9	10		
4841	" 13	9,446·635	61·4	12		
4872	Mar. 5	9,467·716	64·2	12	+13	2
4883	" 12	9,474·697	65·5	6		
4886	" 13	9,475·635	56·9	6	+ 2	1
4903	" 20	9,482·600	63·0	8		
4907	" 22	9,484·600	76·2	10		
4915	" 25	9,487·604	64·8	9	+24	1
4924	" 29	9,491·645	50·7	7	+20	1
4933	Apr. 3	9,496·581	62·7	16		
4940	" 8	9,501·524	75·3	16		
4965	" 19	9,512·538	58·8	9	−10	1
4976	" 23	9,516·543	58·1	8		
5285	Dec. 16	9,753·871	58·2	8		
	1913					
5311	Jan. 8	9,776·830	58·3	10	− 3	4
5315	" 12	9,780·771	65·6	12	+25	4
5339	Feb. 3	9,802·750	56·2	10	+46	1
5350	" 6	9,805·708	43·1	6		
5356	" 10	9,809·687	44·2	8	+ 6	2
5362	" 12	9,811·690	57·1	8		
5372	" 17	9,816·658	53·1	10		
5387	" 23	9,822·632	53·6	14	+16	2
5394	" 24	9,823·697	58·7	14		
5409	" 28	9,827·641	63·5	10		
5418	Mar. 7	9,834·680	60·0	8		
5429	" 11	9,838·674	60·5	8		
5447	Apr. 7	9,865·590	38·9	8		
5456	" 9	9,867·589	54·5	10		
5469	" 14	9,872·607	56·8	6		
5496	" 21	9,879·593	53·5	10		
5851	Dec. 22	2,420,124·836	31·3	8		
5866	" 31	0,133·751	47·8	5		
	1914					
5895	Jan. 21	0,154·727	47·1	10		
5923	Feb. 9	0,173·740	37·8	3		
5940	" 15	0,179·633	36·9	10	+ 9	2
	1916					
7482	Jan. 13	0,876·620	3·2	10		
7519	Feb. 23	0,917·653	13·0	6		
7528	" 29	0,923·664	4·4	4		
7533	Mar. 1	0,924·548	26·7	6		
7606	Apr. 10	0,964·549	26·2	6		
7622	" 27	0,981·561	19·4	7		
	1919					
8701	Jan. 21	1,980·676	37·8	10	− 2	1
8702	" 24	1,983·676	48·2	8		
8708	" 31	1,990·616	37·4	10		
8710	Feb. 10	2,000·571	33·0	12		
8712	" 12	2,002·583	33·2	14		
8713	" 16	2,006·647	30·5	8		
8714	" 16	2,422,006·695	+33·6	10		

MEASURES OF ν GEMINORUM

λ	3743 Vel.	Wt.	3795 Vel.	Wt.	3824 Vel.	Wt.	3848 Vel.	Wt.	3882 Vel.	Wt.	3892 Vel.	Wt.	3910 Vel.	Wt.
4861	+74·5	1/8	+42·8	1/4	+82·3	1/8	+102·6	1/8	+65·6	1/8	+73·2	1/8	+55·6	1/8
4340	81·4	1/4	47·2	1/2	42·9	1/2	53·5	1/2	79·0	1/4	83·6	3/4	41·4	1/2
4101	+54·1	1/4	+35·0	1/4	+59·8	1/8	+ 86·8	1/4	+58·6	1/8	+57·9	1/8	+63·4	1/8
Weighted mean	+ 69·10		+ 43·05		+ 52·28		+ 70·03		+ 70·55		+ 79·09		+ 50·45	
V_a	+ 28·83		+ 16·81		+ 11·13		+ 9·19		+ 5·64		+ 3·02		− 1·58	
V_d	− ·04		·00		− ·27		− ·18		− ·18		− ·18		− ·21	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 97·6		+ 59·6		+ 62·9		+ 78·8		+ 75·7		+ 81·6		+ 48·4	

λ	3924 Vel.	Wt.	3941 Vel.	Wt.	3950 Vel.	Wt.	3975 Vel.	Wt.	3997 Vel.	Wt.	4008 Vel.	Wt.	4021 Vel.	Wt.
4861	+68·4	1/8	+72·6	1/8	+84·1	1/8	+98·6	1/4	+101·0	1/8	+97·8	1/8	+85·3	1/4
4340	55·9	1/2	42·4	1/2	46·8	1/4	122·7	3/4	94·9	1/2	89·3	1/4	91·6	1/2
4101	+63·8	1/8	+69·4	1/8	+61·3	1/8	+101·7	1/2	+100·0	1/8	+60·0	1/8	+79·7	1/8
Weighted mean	+59·30		+51·93		+59·75		+111·68		+96·77		+84·10		+88·10	
V_a	− 6·90		−10·50		−10·04		− 16·95		−23·11		−25·24		−26·50	
V_d	− ·09		− ·28		− ·27		− ·18		− ·22		− ·23		− ·18	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+52·0		+40·9		+49·2		+94·3		+73·2		+58·4		+61·1	

λ	4059 Vel.	Wt.	4069 Vel.	Wt.	4088 Vel.	Wt.	4101 Vel.	Wt.	4115 Vel.	Wt.	4119 Vel.	Wt.	4133 Vel.	Wt.
4861	+70·9	1/8	+104·8	1/4	+105·2	1/4	+ 95·9	1/8	+64·9	1/8	+94·2	1/8	+110·6	1/2
4340	72·4	1/4	92·4	3/4	103·9	3/4	99·0	1/2	109·9	3/4	107·0	1/2	100·7	1
4101	+67·5	1/8	+ 79·8	1/4	+ 96·0	1/8	+113·7	1/8	100·0	1/4	+93·8	1/8	+ 99·2	1/8
3970									+75·9	1/8				
Weighted mean	+70·80		+92·36		+103·31		+100·93		+100·02		+102·67		+103·63	
V_a	−27·97		−28·14		− 28·55		− 29·00		− 29·11		− 29·31		− 29·60	
V_d	− ·23		− ·23		− ·14		− ·20		− ·19		− ·21		− ·18	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+42·3		+63·7		+74·3		+ 71·4		+ 70·4		+ 72·9		+ 73·6	

MEASURES OF ν GEMINORUM—*Continued*

λ	4638		4698		4710		4719		4732		4740		4752	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	+34·8	¼	+48·5	¼	+55·2	¼	+56·1	¼	+67·6	¼	+82·1	¼	+63·1	¼
4340	40·1	¾	42·3	½	59·2	½	53·3	¾	61·7	¾	73·0	¾	82·1	½
4101	+34·6	¼	+13·5	¼	+76·4	⅛	+36·3	¼	+59·5	¼	80·0	¼	+65·9	⅛
3970	......		......		......		......		......		+61·9	¼	......	
Weighted mean	+ 37·94		+ 36·65		+ 60·51		+ 50·46		+ 62·44		+ 73·83		+ 74·36	
V_a	+ 28·86		+ 19·69		+ 12·24		+ 10·80		+ 1·15		+ 1·07		− 5·76	
V_d	− ·02		− ·14		− ·21		− ·14		− ·11		− ·11		− ·14	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 66·5		+ 55·9		+ 72·3		+ 60·8		+ 63·4		+ 74·5		+ 68·2	

λ	4763		4782		4794		4803		4813		4821		4836	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	+88·3	⅛	+83·3	¼	......		+93·9	½	+109·2	⅛	+23·0	¼	+102·0	¼
4340	66·2	½	78·9	¾	+79·4	¾	90·0	1	67·3	¾	46·1	½	94·2	¾
4101	45·0	¼	+74·2	½	+67·3	½	80·3	¼	53·5	¼	+48·8	¼	+ 92·1	¼
3970	+73·3	¼	......		......		+52·7	¼	+56·9	⅛	......		......	
Weighted mean	+65·52		+78·07		+74·56		+85·10		+67·69		+41·00		+95·34	
V_a	− 7·30		− 8·33		−10·32		−11·79		−14·64		−15·09		−21·99	
V_d	− ·18		− ·18		− ·11		− ·18		− ·21		− ·18		− ·18	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+57·8		+69·3		+63·8		+72·8		+52·6		+25·5		+72·9	

λ	4841		4872		4883		4886		4903		4907		4915	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	+99·3	¼	+ 84·0	¼	+123·0	⅛	+83·0	⅛	+98·3	¼	+115·2	¼	+ 70·0	¼
4340	80·0	1	101·3	1	92·3	½	85·7	½	88·5	½	113·1	½	98·7	½
4101	+85·1	¼	+ 67·2	¼	+ 78·0	⅛	+93·1	⅛	+97·0	¼	+ 95·4	½	109·7	¼
3970	......		......		......		......		......		......		+101·6	⅛
Weighted mean	+84·07		+ 92·73		+ 95·03		+ 86·50		+ 93·08		+106·44		+ 95·09	
V_a	−22·32		− 27·93		− 28·98		− 29·06		− 29·64		− 29·72		− 29·77	
V_d	− ·11		− ·28		− ·28		− ·23		− ·21		− ·21		− ·21	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+61·4		+ 64·2		+ 65·5		+ 56·9		+ 63·0		+ 76·2		+ 64·8	

MEASURES OF ν GEMINORUM—*Continued*

λ	4924		4933		4940		4965		4976		5285		5311	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	+76·2	¼	+82·7	½	+116·0	¼	+81·9	⅛	+ 75·8	¼	+33·6	¼	+94·3	¼
4340	83·8	½	95·1	1	106·5	1	87·9	½	81·6	½	71·4	½	62·6	½
4101	+79·4	⅛	95·9	¼	110·4	½	91·4	¼	+100·8	¼	+47·6	¼	58·4	¼
3970	......	...	+99·4	¼	+ 74·9	¼	+81·3	¼	......	...	......	...	+50·0	¼
Weighted mean	+ 81·00		+ 92·65		+104·71		+ 86·54		+ 84·95		+ 56·00		+ 65·58	
V_a	− 29·72		− 29·45		− 28·98		− 27·19		− 26·30		+ 2·78		− 6·71	
V_d	− ·27		·23		− ·18		− ·21		− ·23		− ·25		− ·25	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 50·7		+ 62·7		+ 75·3		+ 58·8		+ 58·1		+ 58·2		+ 58·3	

λ	5315		5339		5350		5356		5362		5372		5387	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	......	...	+55·6	¼	......	...	......	...	+82·2	¼	......	...	......	...
4340	+71·9	¾	80·6	½	+61·2	½	+62·7	¾	79·9	½	+74·9	¾	+81·2	1
4101	79·7	½	84·0	¼	+68·5	¼	+76·8	¼	+77·3	¼	+81·0	½	+77·5	¾
3970	+73·5	¼	+77·2	¼	......	...	......	...	......	...	......	...	......	...
Weighted mean	+ 74·80		+ 75·60		+ 63·63		+ 66·22		+ 79·82		+ 77·36		+ 79·66	
V_a	− 8·69		− 18·88		− 20·03		− 21·53		− 22·26		− 23·89		− 25·62	
V_d	− ·18		− ·25		− ·20		− ·17		− ·18		− ·16		− ·14	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 65·6		+ 56·2		+ 43·1		+ 44·2		+ 57·1		+ 53·1		+ 53·6	

λ	5394		5409		5418		5429		5447		5456		5469	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	+82·1	½	+76·5	¼	+106·2	¼	+98·2	¼	+81·4	¼	+83·3	¼	+85·1	¼
4340	87·0	¾	95·5	½	84·9	½	88·6	½	60·0	½	82·2	¾	80·5	¼
4101	+85·4	½	+93·4	½	+78·8	¼	+84·2	¼	+72·6	¼	+89·9	¼	+91·1	¼
Weighted mean	+ 85·14		+ 90·86		+ 88·70		+ 89·90		+ 68·50		+ 83·96		+ 85·57	
V_a	− 25·89		− 26·85		− 28·22		− 28·81		− 29·12		− 28·89		− 28·16	
V_d	− ·25		− ·18		− ·25		− ·27		− ·25		− ·25		− ·28	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 58·7		+ 63·5		+ 60·0		+ 60·5		+ 38·9		+ 54·5		+ 56·8	

MEASURES OF ν GEMINORUM—*Concluded*

λ	5496		5851		5866		5895		5923		5940		7482	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	+86·1	¼	....	....	+53·2	⅛	+58·1	¼	+59·9	⅛	+60·4	¼	+12·2	½
4340	81·4	¾	+19·3	½	45·6	¼	56·7	½	+59·1	¼	60·6	¾	15·7	½
4101	+74·1	¼	+39·6	½	+54·2	¼	+65·5	½	....	....	+60·0	¼	+ 4·6	¼
Weighted mean	+ 80·88		+ 29·45		+ 50·56		+ 60·50		+ 59·37		+ 60·44		+ 12·08	
V_a	− 26·83		+ 2·37		− 2·33		− 12·97		− 21·09		− 23·16		− 8·74	
V_d	− ·23		− ·20		− ·10		− ·14		− ·25		− ·11		+ ·09	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 53·5		+ 31·3		+ 47·8		+ 47·1		+ 37·8		+ 36·9		+ 3·2	

λ	8701		8702		8708		8710		8712		8713		8714	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861	+76·1	¼	+76·4	¼	+85·2	¼	+63·1	½	+61·9	½	+93·8	¼	+76·7	½
4340	41·0	¾	62·1	½	48·6	¾	52·0	¾	52·4	¾	33·4	½	35·7	½
4101	+56·8	¼	+50·8	¼	+44·4	¼	+45·1	¼	+53·7	½	+56·7	¼	+63·0	¼
Weighted mean	+ 50·98		+ 62·85		+ 55·08		+ 54·55		+ 55·50		+ 54·32		+ 57·56	
V_a	− 12·81		− 14·26		− 17·35		− 21·32		− 22·04		− 23·43		− 23·43	
V_d	− ·06		− ·09		− ·02		+ ·04		·00		− ·13		− ·21	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 37·8		+ 48·2		+ 37·4		+ 33·0		+ 33·2		+ 30·5		+ 33·6	

GROUPED VELOCITIES

Observatory	Epoch	Number of Plates	Velocity	O−C
Yerkes	1903·95	2	+27·5	−18
"	1906·16	1	6·	−12
"	1908·07	1	15·	+ 3
"	1909·00	1	20·	− 6
Ottawa	1910·97	22	70·0	+ 0·4
"	1911·95	26	63·9	− 3·0
"	1913·13	17	55·6	+ 2·7
"	1914·05	5	40·1	0·0
"	1916·18	6	14·9	0·0
"	1919·09	7	+36·0	0·0

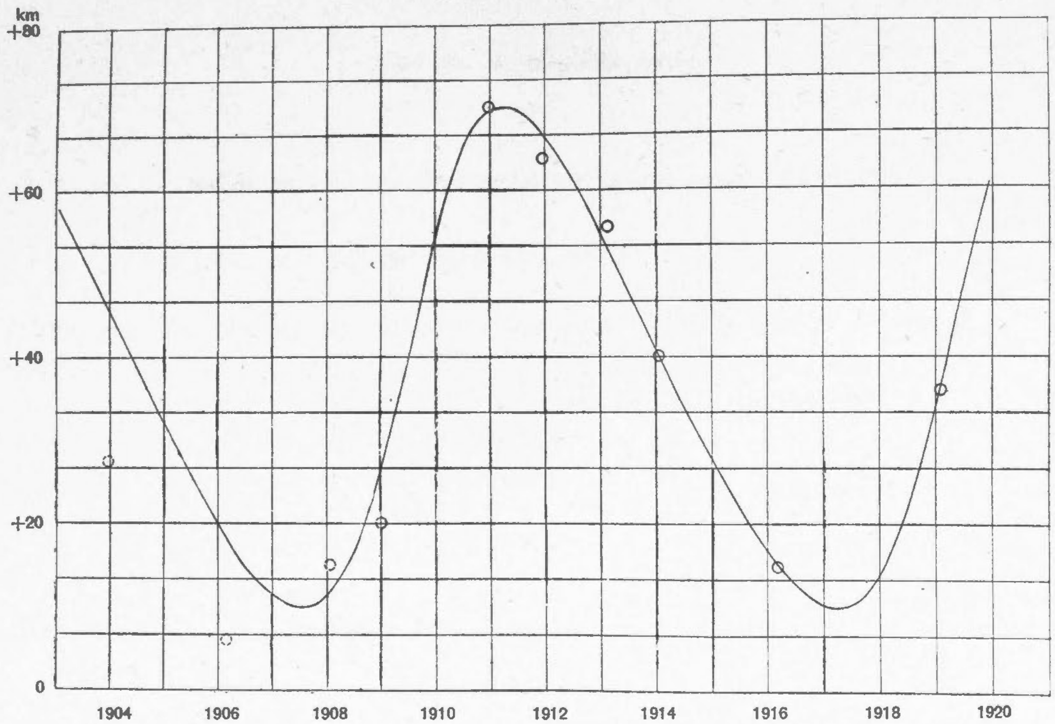
These velocities are plotted on the accompanying graph, in which the curve shown represents the following elements. The curve was obtained graphically with only a few trials and no attempt has been made to improve the elements by a least-squares solution.

PROVISIONAL ELEMENTS

P = 9·6 years
e = ·20
ω = 285°
γ = +38·45 km.
K = 30·0 km.
T = 1909·75
$a \sin i$ = 1,417,000,000 km.

The general character of the spectrum would seem to bear out this long-period variation. The spectrum of the star which gives the fairly sharp lines whose measures are here recorded, and which may be called component 1, would seem to overlie that of one (component 2) consisting of faint and very broad bands, so broad in fact that they were never separated from the other. When the velocities for component 1 were at their maximum around 1911, the spectral lines were nearly at the extreme red edge of the broad bands corresponding to component 2. The minimum is not so well recorded, but apparently at that time there is more of the band showing to the red than to the violet. At intermediate points the principal lines are more nearly central on the bands. Minor variations, due possibly to the third component of the triple system, whose period is as yet undetermined, complicate matters but the foregoing, while given with a certain amount of reserve, seems to describe the general character of the spectrum. It is hoped to follow the star from time to time to more definitely determine the elements.

Dominion Observatory
Ottawa
February, 1919.



Radial Velocity Curve of ν Geminorum

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 20

MEASURES OF RADIAL VELOCITY OF 23 COMÆ BERENICES, δ SERPENTIS AND χ SERPENTIS

BY W. E. HARPER, M.A.

MEASURES OF RADIAL VELOCITY OF 23 COMÆ BERENICES

(1900, $\alpha = 12^h\ 29^m{\cdot}9$, $\delta = +\ 23°\ 11'$, mag. 4·78, type A)

This star was announced a spectroscopic binary by Lee, in the *Astrophysical Journal*, XXXII, p. 304, from 5 plates, in which 3 of the plates showed complexities of the lines. Later, Professor Frost, with his usual kindness in such matters, sent the writer these three plates with the remark, "that while the duplicities are not remarkably obvious yet one or more lines seem to be safely double". At a first glance one would rather hesitate to accept the duplicity of the lines, but a closer examination shows the possibility, at least, of such an interpretation being placed upon them.

Seventy-seven plates have been taken here without any decisive evidence of the component spectra. In addition to the hydrogen series, the *K* line of calcium λ 3933, the magnesium line λ 4481 and the iron line at λ 4549 are recorded in the order of decreasing intensity. The mean value of the velocities, which do not vary over a great range, is − 16·2 km. per sec.; Campbell, in *Lick Observatory Bulletin* No. 211, used − 20 km. per sec. from the Yerkes results combined with six of his own. Nevertheless, from the changes which take place in the widths and intensities of the lines, particularly in the case of λ 4481 and λ 4549, it would seem to be beyond a doubt that two quite similar spectra are present, but that the lines are never sufficiently separated to be resolved on our plates. On many plates the λ 4481 line is quite faint, while λ 4549 disappears altogether. At other times, presumably when the spectra are superposed, these are narrow, well-defined lines. Practically all the plates have been measured twice.

The curve of velocity-frequency suggests a binary in which the probable error of measurement is from one-third to one-half the total range of variation (See Young, *R.A.S.C. Journal*, X, page 366). Higher dispersion than one-prism and the use of fine-grained plates, which give better lines for measurement, are necessary for a successful effort to get its orbit.

SUMMARY OF MEASURES OF 23 COMÆ

Plate	Plate	Date		Julian Day	Velocity	n	Remarks
		1908					
1491	S. 27	April	15	2,418,047·767	−23·9	5	
		1911					
4073	S. 27	Mar.	7	2,419,103·774	−25·6	1	4481 dependable.
4095	S. 27	"	10	106·883	−10·0	4	
4131	S. 27	"	18	114·711	−12·0	4	sl. underexposed, lines fuzzy.
4148	S. 27	"	28	124·843	− 4·9	3	4481 not strong.
4165	S. 27	April	3	130·805	−27·8	3	sl. underexposed, lines fair.
4191	S. 27	"	11	138·789	−19·3	4	4481 suggests close double.
4198	S. 27	"	17	144·705	−20·2	4	
4217	S. 27	"	19	146·758	−18·7	3	poor agreement.
4223	S. 27	"	20	147·748	−24·4	4	lines fair, but *K* not accordant.
4259	S. 27	"	25	152·725	−33·0	3	lines good.
4356	S. 27	June	8	196·571	−19·0	4	lines good.
		1912					
4785	S. 30	Jan.	12	414·934	− 6·5	3	poor plate.
4811	S. 30	"	19	421·968	−14·6	3	
4816	S. 30	"	25	427·884	−10·6	4	lines only fair.
4846	S. 30	Feb.	14	447·827	−14·9	3	4549 and 4481 very faint.
4865	S. 30	"	28	461·889	−14·0	2	
4877	S. 30	Mar.	10	472·816	−21·0	3	4481 faint, yet reliable.
4889	S. 30	"	13	475·812	−29·5	4	4481 faint, *K* suspicious double.
4897	S. 30	"	18	480·821	− [illegible]·3	3	sl. underexposed.
4910	S. 30	"	22	484·779	−16·5	3	fair.
4918	S. 30	"	25	487·787	−29·4	2	4481 and *K* dependable.
4926	S. 30	"	29	491·801	−18·4	4	*K* good, others diffuse.
4930	S. 30	"	31	493·734	−24·7	3	*K* fair, others ill-defined.
4936	S. 30	April	3	496·771	−30·3	4	only fair, poor agreement.
4943	S. 30	"	8	501·701	− 7·3	3	*K* −42·0, real difference.
4949	S. 30	"	11	504·779	−27·7	1	*K* a good line.
4955	S. 30	"	12	505·750	−20·8	3	*H* suspicious double.
4968	S. 30	"	19	512·731	−12·3	3	fair.
4972	S. 30	"	20	513·699	−29·2	1	*K* alone dependable.
4979	S. 30	"	23	516·730	−20·8	4	lines little fuzzy.
4987	S. 30	"	27	520·725	−11·8	3	fair plate.
4995	S. 30	"	30	523·753	−10·8	4	plate not the best.
5000	S. 30	May	2	525·702	−16·9	3	not very dependable.
5017	S. 30	"	15	538·632	−15·3	2	not very dependable.
5026	S. 23	"	31	554·619	−10·4	4	excellent agreement.
5034	S. 23	June	6	560·597	−24·2	1	underexposed.
5040	S. 23	"	7	561·670	− 1·8	4	good.
5044	S. 30	"	12	566·600	− 8·2	4	fair lines, poor agreement.
5053	S. 23	"	17	571·622	−26·0	2	several metallic lines, *K* broadened.
5057	S. 23	"	18	572·671	± 0·0	1	4481 very sharp; 4549 broad and −40.
5061	S. 23	"	21	575·619	− 5·8	1	4481 good; 4549 narrow but −40.
5063	S. 23	"	24	578·607	−14·4	1	underexposed.
5067	S. 23	"	25	579·632	− 3·4	2	underexposed. 4481, 4549 agree.
5077	S. 23	"	27	581·604	−24·8	2	4481, 4549 sharp.
5085	S. 23	July	2	586·606	− 5·4	3	underexposed but fair lines.
5105	S. 23	"	16	600·591	−14·0	3	same as 5085.
		1913					
5343	S. 27	Feb.	3	802·897	+ 0·1	4	fair.
5353	S. 27	"	6	805·892	+ 2·6	3	fair.
5366	S. 27	"	12	811·888	−21·7	3	sl. underexposed.
5375	S. 27	"	17	816·771	−22·1	5	lines sl. fuzzy.
5386	S. 27	"	18	817·740	−20·2	4	not best agreement.

SUMMARY OF MEASURES OF 23 COMÆ—*Concluded*

Plate	Plate	Date		Julian Day	Velocity	*n*	Remarks
		1913					
5389	S. 27	Feb.	23	2,419,822·758	−13·3	5	fairly narrow lines.
5399	S. 27	"	24	823·832	−16·4	4	fair plate.
5403	S. 27	"	25	824·785	−15·2	4	poor lines, tempr. change.
5404	S. 27	"	25	824·833	−21·1	4	4481 ill-defined.
5411	S. 27	"	28	827·734	−24·3	4	4481 fairly sharp.
5422	S. 27	Mar.	7	834·811	− 4·1	3	barely trace 4481, 4549.
5440	S. 27	"	17	844·725	−11·6	5	4481, 4549 no contrast.
5442	S. 27	April	1	859·772	−22·4	4	4481 faint.
5449	S. 27	"	7	865·687	−20·5	4	*K* ill-defined.
5458	S. 27	"	9	867·673	−24·0	4	fair, agreement not best.
5464	S. 27	"	13	871·722	−20·4	4	agreement poor, 4481 sharp.
5471	S. 27	"	14	872·694	−13·1	4	all lines distinct.
5477	S. 27	"	15	873·759	− 4·9	4	poor plate.
5481	S. 27	"	16	874·668	−18·2	4	4481 and *K* sl. fuzzy.
5491	S. 27	"	17	875·691	− 9·4	3	4481 fair but poor agreement.
5493	S. 27	"	20	878·658	−17·6	5	only fair.
5505	S. 27	"	24	882·603	−18·9	5	4481, 4509 narrow, distinct.
5515	S. 27	"	29	887·768	−30·9	4	4481, 4549 ill-defined.
5519	S. 27	"	30	888·749	− 9·3	3	fair lines.
5523	S. 27	May	1	889·600	−21·9	5	4549 narrow, others broad.
5529	S. 23	"	2	890·611	−23·1	3	4481 narrow, strong.
5538	S. 27	"	7	895·604	−15·5	3	all fairly definite.
5555	S. 27	"	25	913·646	−12·8	2	4481 fair, others uncertain.
5558	S. 27	"	29	917·585	+ 6·8	3	4481 best, alone gives −2.
5586	S. 27	June	16	2,419,935·598	−26·0	2	

MEASURES OF 23 COMÆ

λ	1491		4073		4095		4131		4148		4165		4191	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	−27·8	½	......	...	− 8·4	¾	− 5·3	¼	......	...	−30·7	¼	−29·2	½
4481	13·6	1	−30·8	1	20·3	1½	13·3	¼	......	...	8·0	¾	− 8·0	1
4340	12·5	½	......	...	10·0	½	8·8	½	− 1·4	¾	......	...	−12·4	½
4101	0·3	½	......	...	......	...	......	...	− 1·2	¼	......	...	......	...
3933	− 4·0	1	......	...	− 8·1	½	−30·3	⅛	+ 1·4	1	−46·2	¼	+ 4·2	1
Weighted mean	− 10·83		− 30·83		− 13·57		− 12·15		+ 0·02		− 20·16		− 8·20	
V_a	− 12·60		+ 5·46		+ 4·01		+ 0·32		− 4·42		− 7·13		− 10·62	
V_d	− ·19		·00		− ·20		+ ·09		− ·21		− ·19		− ·20	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 23·9		− 25·6		− 10·0		− 12·0		− 4·9		− 27·8		− 19·3	

λ	4198		4217		4223		4259		4356		4785		4811	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	−14·3	⅛	......	...	−23·3	¾	......	...	......	...	......	...	......	...
4481	2·3	¼	−30·5	⅛	−10·0	¾	−13·3	1	+ 8·2	1	−26·8	⅛	−29·4	½
4340	8·7	½	+ 9·6	¼	−23·9	¾	17·2	¾	+10·0	1¼	39·3	¼	50·0	½
4101	......	...	......	...	......	...	......	...	− 0·6	½	......	...	......	...
3933	− 5·9	1	− 6·0	⅛	+18·6	¾	−18·9	1	+ 8·3	¾	−28·4	½	−33·8	½
Weighted mean	− 6·72		− 4·33		− 9·65		− 16·40		+ 7·66		− 31·28		− 37·73	
V_a	− 13·07		− 13·87		− 14·27		− 16·15		− 26·30		+ 25·13		+ 23·52	
V_d	− ·09		− ·18		− ·17		− ·14		− ·10		− ·04		− ·11	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 20·2		− 18·7		− 24·4		− 33·0		− 19·0		− 6·5		− 14·6	

MEASURES OF 23 COMÆ—*Continued*

λ	4816		4846		4865		4877		4889		4897		4910	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481	−18·3	½	−45·6	½	−18·0	¾	−29·5	½	−41·1	¾	− 7·6	¼	− 4·4	½
4340	41·6	¾	20·0	½	......	...	15·2	¾	29·5	¾	+ 5·0	¼	11·8	1¼
4101	37·5	¼	......	...	......	...	......	...	9·6	½	......	...	......	...
3933	−30·4	¾	−22·9	½	−26·6	¾	−32·3	½	−41·6	½	− 3·8	¾	−24·7	¾
Weighted mean	− 32·22		− 29·50		− 22·30		− 24·17		− 31·42		− 2·80		− 14·16	
V_a	+ 21·89		+ 14·81		+ 8·74		+ 3·58		+ 2·27		− 0·13		− 1·93	
V_d	·00		+ ·03		− ·17		− ·10		− ·11		− ·13		− ·10	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 10·6		− 14·9		− 14·0		− 21·0		− 29·5		− 3·3		− 16·5	

λ	4918		4926		4930		4936		4943		4949		4955	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481	......	...	+ 3·9	¼	−11·5	¼	−46·6	½	+ 2·4	¼	......	...	− 5·8	½
4340	−25·3	½	−10·4	½	8·1	¼	9·6	¼	3·2	¾	......	...	29·4	½
4101	......	...	+ 2·7	¼	......	...	18·8	¼	+ 2·1	½	......	...	......	...
3933	−26·5	1	−22·0	1	−23·9	¾	−11·8	¾	......	...	−16·2	1¼	− 0·5	1
Weighted mean	− 26·10		− 12·75		− 18·26		− 22·43		+ 2·70		− 16·20		− 9·05	
V_a	− 2·93		− 5·25		− 6·13		− 7·49		− 9·66		− 10·98		− 11·38	
V_d	− ·11		− ·14		− ·05		− ·12		− ·04		− ·18		− ·13	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 29·4		− 18·4		− 24·7		− 30·3		− 7·3		− 27·7		− 20·8	

MEASURES OF 23 COMÆ—*Continued*

λ	4968		4972		4979		4987		4995		5000		5017	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	...	...	...	...	−11·5	½	...	...	...	...	...	...	...	...
4481	−11·1	¼	...	...	−14·3	½	+ 9·8	¾	+14·2	½	−12·0	½	+18·6	½
4340	+ 3·0	¼	...	...	+19·9	¼	− 1·7	½	+16·3	½	+ 0·3	½	...	...
4101	...	...	...	...	...	...	...	...	− 6·0	¼	...	...	...	...
3933	+ 6·6	¾	−14·2	1	− 1·9	¾	+ 7·0	¾	+ 2·9	¾	+10·7	1	− 3·3	½
Weighted mean	+ 2·34		− 14·20		− 4·65		+ 5·85		+ 7·90		+ 2·40		+ 7·65	
V_a	− 14·21		− 14·59		− 15·73		− 17·18		− 18·19		− 18·86		− 22·55	
V_d	− ·13		− ·10		− ·15		− ·16		− ·21		− ·14		− ·09	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 12·3		− 29·2		− 20·8		− 11·8		− 10·8		− 16·9		− 15·3	

λ	5026		5034		5040		5044		5053		5057		5061	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481	+15·3	1	+ 2·5	¾	+29·0	1	+38·2	½	+ 2·9	1	+27·6	1½	+21·4	1
4340	16·2	1	...	...	25·9	½	17·7	½	− 3·2	¼	...	...	...	...
4101	16·3	½	...	...	31·4	½	24·0	¼	...	...	...	...	...	...
3933	+15·2	1½	...	...	+17·6	1	+ 5·0	¾	...	...	...	...	...	...
Weighted mean	+ 15·61		+ 2·50		+ 25·10		+ 18·85		+ 1·68		+ 27·60		+ 21·40	
V_a	− 25·60		− 26·24		− 26·35		− 26·64		− 27·14		− 27·04		− 26·72	
V_d	− ·13		− ·13		− ·23		− ·16		− ·21		− ·28		− ·22	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 10·4		− 24·2		− 1·8		− 8·2		− 26·0		± 0·0		− 5·8	

MEASURES OF 23 COMÆ—*Continued*

λ	5063 Vel.	5063 Wt.	5067 Vel.	5067 Wt.	5077 Vel.	5077 Wt.	5085 Vel.	5085 Wt.	5105 Vel.	5105 Wt.	5343 Vel.	5343 Wt.	5353 Vel.	5353 Wt.
4549	...	...	+24·7	¾	− 4·0	1	+28·5	¾	+19·5	½	...	...	...	...
4481	+12·7	¾	+22·7	¾	+ 8·3	1	16·9	1½	5·1	1	−21·0	½	−13·7	1
4340	...	...	...	...	...	...	...	...	...	...	0·4	¾	6·8	¾
4101	...	...	...	...	...	...	...	...	...	...	24·4	½	...	...
3933	...	...	...	...	...	...	+20·7	½	+12·0	½	−35·6	½	−23·6	¾
Weighted mean	+ 12·70		+ 23·70		+ 2·15		+ 21·15		+ 10·42		− 18·13		− 14·60	
V_a	− 26·60		− 26·56		− 26·48		− 26·01		− 23·83		+ 18·66		+ 17·57	
V_d	− ·22		− ·25		− ·22		− ·25		− ·27		− ·11		− ·09	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 14·4		− 3·4		− 24·8		− 5·4		− 14·0		+ 0·1		+ 2·6	

λ	5366 Vel.	5366 Wt.	5375 Vel.	5375 Wt.	5386 Vel.	5386 Wt.	5389 Vel.	5389 Wt.	5399 Vel.	5399 Wt.	5403 Vel.	5403 Wt.	5404 Vel.	5404 Wt.
4549	...	...	−53·6	¾	−34·0	½	−19·2	½	−22·6	¼	...	...	−35·4	¼
4481	−23·2	½	18·9	½	44·3	¾	14·0	1	29·4	¾	−10·7	½	34·0	¼
4340	38·5	½	49·8	¼	19·2	1	40·6	½	26·6	¼	25·0	¾	21·4	¾
4101	...	...	21·2	½	...	...	7·3	¼	...	...	27·7	¾	...	...
3933	−42·4	1	−32·0	¾	−30·5	¾	−34·1	¾	−23·3	½	−34·1	½	−35·6	¾
Weighted mean	− 36·60		− 35·16		− 32·85		− 23·77		− 26·23		− 24·77		− 30·50	
V_a	+ 15·25		+ 13·24		+ 12·83		+ 10·65		+ 10·21		+ 9·75		+ 9·75	
V_d	− ·11		+ ·10		+ ·14		+ ·10		− ·07		+ ·06		− ·07	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 21·7		− 22·1		− 20·2		− 13·3		− 16·4		− 15·2		− 21·1	

MEASURES OF 23 COMÆ—*Continued*

λ	5411		5422		5440		5442		5449		5458		5464	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	−30·0	½	....	....	− 1·6	½	....	....	....	....	−10·7	¼	....	....
4481	35·5	1	....	....	1·9	½	−20·7	½	−15·6	1	−18·9	¾	−27·1	¾
4340	31·6	¼	− 4·2	½	10·5	1	19·2	¾	− 8·5	¼	+ 7·6	½	− 2·5	¼
4101	....	....	14·2	¼	27·4	¼	9·2	¼	+ 2·6	¼	....	....	− 1·1	½
3933	−29·1	½	−10·3	¾	−22·0	¾	−14·3	¾	−10·0	½	−26·8	¾	+ 6·0	¾
Weighted mean	− 32·40		− 8·92		− 11·87		− 15·57		− 11·00		− 14·71		− 8·40	
V_a	+ 8·42		+ 5·16		+ 0·50		− 6·49		− 9·19		− 9·98		− 11·67	
V_d	·00		− ·09		+ ·04		− ·11		·00		+ ·02		− ·09	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 24·3		− 4·1		− 11·6		− 22·4		− 20·5		− 24·0		− 20·4	

λ	5471		5477		5481		5491		5493		5505		5515	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	− 1·7	1	+ 7·7	¼	....	....	+10·0	¼	+15·7	½	+ 9·3	1	....	....
4481	+ 1·6	1	+24·9	½	− 1·9	½	− 8·5	¾	− 7·4	½	−10·3	¾	− 0·5	½
4340	+ 4·1	½	−12·4	½	−12·1	¾	+20·4	½	+ 1·4	½	+ 5·9	½	−13·7	½
4101	....	....	....	....	− 0·5	¼	....	....	−21·1	½	− 0·8	½	+ 1·1	½
3933	− 5·9	1	+10·4	1	+ ·07	½	....	....	+ 5·2	½	−26·1	½	−24·8	1
Weighted mean	− 0·70		+ 8·09		− 4·90		+ 4·27		− 2·84		− 2·72		− 12·56	
V_a	− 12·09		− 12·53		− 12·97		− 13·35		− 14·47		− 15·95		− 17·80	
V_d	− ·04		− ·16		·00		− ·07		·00		+ ·02		− ·22	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 13·1		− 4·9		− 18·2		− 9·4		− 17·6		− 18·9		− 30·9	

MEASURES OF 23 COMÆ—*Concluded*

λ	5519		5523		5529		5538		5555		5558		5586	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	+14·3	1	− 4·5	1	− 1·8	½	+10·6	¾	.....	.....	.....	.....	0·0	½
4481	7·1	1	− 0·6	½	+ 3·0	1½	2·2	¾	+18·0	¾	+23·3	1	+ 2·0	¾
4340	.....	.....	− 2·9	½	−27·8	½	.....	.....	− 5·0	½	48·0	¾	.....	.....
4101	.....	.....	+ 4·2	½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3933	+ 6·7	1	−10·5	½	.....	.....	+ 2·6	¾	.....	.....	+27·5	½	.....	.....
Weighted mean	+ 9·37		− 3·13		− 4·12		+ 5·15		+ 12·25		+ 32·47		+ 1·20	
V_a	− 18·17		− 18·54		− 18·76		− 20·36		− 24·61		− 25·25		− 26·75	
V_d	− ·21		+ ·04		+ ·02		·00		− ·14		− ·09		− ·18	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 9·3		− 21·9		− 23·1		− 15·5		− 12·8		+ 6·8		− 26·0	

Dominion Observatory
Ottawa
April, 1919.

MEASURES OF RADIAL VELOCITY OF δ SERPENTIS

BY W. E. HARPER, M.A.

(1900, $\alpha = 15^h\ 30^m \cdot 0$, $\delta = +10° 53'$, mag. 4·23, type A5)

This star was announced a spectroscopic binary by Campbell, in *Lick Observatory Bulletin* No. 199, from 5 plates scattered over the years 1905 to 1911. The range of velocity from the five plates—considering the mean of the measures on each—is from −26 to − 52 km. per second.

Forty-three plates were made here with the single-prism spectrograph, mostly in the year 1913, as given in the accompanying table of measures. The spectrum is characterized by intensely strong *H* and *K* lines of calcium, moderately strong hydrogen, and faint and diffuse metallic lines. There is a 5·2 magnitude star of the same type about 3″ distant, in position angle 180°, which on nights of poor seeing is confused with the main star, but any effect its spectrum might have on the measures is negligible. Apart from one or two plates, our measures lie between − 38 and − 53 km. per sec. and it has not been possible to obtain a satisfactory period, though the curve of velocity-frequencies would verify the binary character of the star. If the better plates of our own observatory were alone considered, a curve whose period is approximately four months and a range of 15 km. might be suggested, but the Lick observations do not bear this out.

The second column of the table of lines used indicates the number of times the line was measured. The residuals are in the sense, mean minus measured. No revision of the wave-lengths has been made.

LINES USED IN δ SERPENTIS

λ	n	Residual		λ	n	Residual	
		Num.	Alg.			Num.	Alg.
4549·766	30	11·4	+ 7·4	4250·616	3	12·8	+ 4·6
4534·139	6	10·6	+ 8·0	4246·996	3	6·9	− 6·9
4481·400	36	9·4	− 4·1	4233·328	14	7·3	− 4·6
4443·976	4	9·7	+ 9·7	4227·010	9	5·4	+ 1·2
4395·286	7	14·4	+14·4	4198·494	11	12·4	−11·7
4375·103	11	10·9	+ 3·5	4143·928	8	12·3	+ 8·5
4352·006	6	15·2	+ 2·7	4101·890	12	11·6	− 0·5
4340·634	32	8·2	− 1·1	4063·756	10	15·7	+ 1·6
4325·939	20	8·8	+ 2·8	4045·975	25	6·3	+ 2·9
4289·915	15	13·3	−12·1	4005·430	10	8·7	− 2·7
4271·760	11	9·5	+ 2·2	3933·825	1	11·8	+11·8

SUMMARY OF MEASURES OF δ SERPENTIS

Plate	Date	Julian Date	n	Wt.	Vel.	Remarks
	1913					
5344	Feb. 3	2,419,802·944	8	4	−52	
5355	" 6	805·961	6	3	42	
5367	" 12	811·935	10	5	38	
5379	" 17	816·882	8	4	38	
5401	" 24	823·923	8	4	39	
5406	" 25	824·913	6	2	48	underexposed.
5424	Mar. 7	834·896	5	2	40	underexposed.
5444	April 1	859·857	8	4	40	
5462	" 9	867·790	4	2	62	poor plate.
5466	" 13	871·814	3	2	59	only fair.
5475	" 14	872·805	7	4	54	
5479	" 15	873·834	7	3	52	
5485	" 16	874·804	9	4	46	
5495	" 20	878·753	7	4	53	
5501	" 23	881·753	5	2	52	underexposed.
5509	" 24	882·724	4	2	48	
5513	" 25	883·808	4	2	29	poor plate.
5517	" 29	887·847	6	3	50	
5521	" 30	888·833	8	4	53	
5527	May 1	889·708	7	3	48	
5533	" 2	890·744	8	3	48	underexposed.
5542	" 7	895·734	6	3	54	
5547	" 11	899·801	4	2	39	poor plate.
5553	" 14	902·816	10	5	50	
5557	" 25	913·744	7	3	45	
5562	" 29	917·708	7	3	44	
5565	June 4	923·748	5	3	38	underexposed.
5571	" 8	927·707	8	4	42	
5575	" 9	928·675	8	4	42	
5582	" 13	932·687	8	3	37	underexposed.
5588	" 16	935·690	5	3	42	
5594	" 18	937·692	6	3	38	narrow spectrum.
5596	" 20	939·702	2	1	25	very poor plate.
5597	" 23	942·755	9	4	39	fuzzy lines.
5605	July 2	951·651	4	2	51	very poor plate.
5608	" 7	956·676	6	3	43	
5619	" 14	963·659	7	3	42	fuzzy lines.
5631	" 25	974·619	5	2	38	narrow spectrum.
5638	" 30	979·591	6	3	42	
5644	Aug. 6	2,419,986·584	8	4	−41	
	1914					
5961	Feb. 23	2,420,187·862	10	4	−28	
6234	July 30	344·560	7	3	−52	narrow slit.
	1915					
6803	Feb. 18	547·881	10	5	−31	excellent plate.

MEASURES OF δ SERPENTIS

λ	5344		5355		5367		5379		5401		5406		5424	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549			−65·1	½	−58·9	½	−67·7	½						
4481	−83·9	¾	76·0	½	59·5	½	70·0	½	−59·2	½			−55·4	¾
4395							55·5	½			−79·3	½		
4375											67·7	¾		
4352					80·1	¼								
4340	77·2	¾	68·1	½	59·2	¾	49·9	½	61·3	¾	73·4	¾	57·5	½
4325	81·2	¾			50·4	½	72·3	½			77·2	¾		
4271	75·4	½											66·3	½
4233			59·6	½			72·5	½			60·7	½	62·0	½
4198									53·7	½				
4143	90·2	½			54·2	¼			78·2	½				
4101	62·1	¾	75·0	½	74·6	¾			50·3	½				
4063	84·7	¼			67·0	½			83·2	½				
4045	−86·9	¼			60·0	1	68·1	½	81·6	½				
4005			−64·4	½	−71·1	1	−54·7	½	−54·3	½	−71·5	½	−76·8	½
Weighted mean	− 78·69		− 68·03		− 63·80		− 63·84		− 63·82		− 71·84		− 62·84	
V_a	+ 26·39		+ 26·41		+ 26·21		+ 25·84		+ 24·97		+ 24·83		+ 22·89	
V_d	+ ·09		+ ·06		+ ·03		+ ·12		·00		− ·19		·00	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 52·5		− 41·8		− 37·8		− 38·2		− 39·1		− 47·5		− 40·2	

λ	5444		5462		5466		5475		5479		5485		5495	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549									−52·8	½	−48·7	½	−65·2	½
4481	−37·4	½			−69·3	½	−58·5	¾	59·4	½	56·6	½	39·3	½
4443											44·8	½		
4340	67·4	½			75·2	¾	58·6	¾	51·7	½	64·7	½	66·3	½
4325			−87·3	½			69·5	½	45·8	½	44·4	½	60·3	¾
4290	76·3	½											63·2	½
4271	67·2	½							71·5	½				
4233	63·4	½	74·7	½	−62·9	¾					58·1	½		
4227							67·5	¼			44·6	½	63·7	½
4198	53·9	½												
4143	35·9	¾					72·2	½			63·0	½	−64·9	¾
4101							69·2	¾						
4063			57·6	½					87·2	½	−73·3	½		
4045	−50·2	¾	−77·7	½			−61·7	½	−61·7	½				
Weighted mean	− 54·98		− 74·32		− 69·10		− 64·52		− 61·44		− 55·36		− 60·62	
V_a	+ 15·34		+ 12·31		+ 10·79		+ 10·28		+ 9·89		+ 9·46		+ 7·79	
V_d	− ·11		+ ·04		− ·02		− ·02		− ·09		− ·04		+ ·05	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 40·0		− 62·2		− 58·6		− 54·5		− 51·9		− 46·2		− 53·1	

MEASURES OF δ SERPENTIS—*Continued*

λ	5501 Vel.	5501 Wt.	5509 Vel.	5509 Wt.	5513 Vel.	5513 Wt.	5517 Vel.	5517 Wt.	5521 Vel.	5521 Wt.	5527 Vel.	5527 Wt.	5533 Vel.	5533 Wt.
4549	−39·7	½	−66·9	¾	−39·2	½	−56·6	½	−57·6	½	−53·9	½	−37·5	½
4534	68·9	½			40·4	½			56·6	½	61·0	½	48·6	½
4481			34·2	¾	33·7	½	73·9	½			47·3	½	50·7	½
4395													64·6	½
4352									40·3	½				
4340	57·7	½			−23·5	½	48·7	½	48·1	½	60·4	½		
4325											43·9	½	55·4	½
4290	67·4	½	58·8	½			39·2	½	43·0	½	51·2	½	46·8	½
4233							67·1	½	62·1	½				
4227							−47·3	½						
4198									62·4	½	−39·9	½		
4101									−74·9	½				
4063													36·6	½
4045	−57·4	½	−59·7	½									−61·3	½
Weighted mean	− 58·22		− 54·00		− 34·20		− 53·80		− 55·62		− 51·09		− 50·20	
V_a	+ 6·53		+ 6·11		+ 5·69		+ 3·86		+ 3·43		+ 3·00		+ 2·57	
V_d	− ·12		+ ·09		− ·09		− ·17		− ·14		+ ·09		·00	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 52·1		− 48·1		− 28·9		− 50·4		− 52·6		− 48·3		− 47·9	

λ	5542 Vel.	5542 Wt.	5547 Vel.	5547 Wt.	5553 Vel.	5553 Wt.	5557 Vel.	5557 Wt.	5562 Vel.	5562 Wt.	5565 Vel.	5565 Wt.	5571 Vel.	5571 Wt.
4549	−60·1	½	−16·6	¼	−57·6	½	−24·0	½	−26·1	1	− 5·5	¾	−31·8	½
4534					46·3	½	19·9	½						
4481	56·6	½	38·5	¼	43·0	½	39·1	½	44·2	½	35·6	½	23·8	½
4443	52·3	½												
4395	60·4	½											19·6	½
4375					52·1	½	49·3	½	27·5	½	22·7	1		
4352											49·0	½		
4340	50·0	¾			30·1	½	57·3	½	48·3	½			21·0	½
4325			37·5	½	62·3	½							48·3	½
4271									25·7	¼			39·9	¾
4246							30·9	½						
4233					36·2	½								
4227					52·7	½	−37·3	½	37·9	½				
4198											−28·4	½	23·9	½
4143	−47·3	¾												
4101					41·4	½								
4045			−46·9	½	−47·2	½			−40·3	½			−16·9	½
Weighted mean	− 53·60		− 37·27		− 46·89		− 36·83		− 35·09		− 25·72		− 28·85	
V_a	+ 0·39		− 1·40		− 2·75		− 7·33		− 9·01		− 11·36		− 12·93	
V_d	·00		− ·15		− ·09		− ·12		− ·08		− ·17		− ·12	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 53·5		− 39·1		− 50·0		− 44·6		− 44·5		− 37·5		− 42·2	

MEASURES OF δ SERPENTIS—*Continued*

λ	5575		5582		5588		5594		5597		5605		5608	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	−34·1	½	−35·6	½	−38·7	¾	− 7·2	¾	−35·5	¾			−36·3	½
4534									24·2	½				
4481	29·8	½	25·1	½			30·5	½	24·1	½	−17·1	½	11·2	½
4443							29·3	½						
4395									18·7	½				
4375	17·6	½			7·8	½	32·5	½	41·6	½	45·9	½		
4352							21·2	½	3·8	½				
4340	28·3	½	16·3	½									26·1	½
4325			30·4	½					5·3	½	29·1	½	17·4	½
4290	24·2	½											6·3	½
4271			15·7	¾	35·2	½								
4246											−26·7	½		
4233					28·3	½								
4227			22·3	¼										
4198	42·3	½							14·2	½				
4101	18·8	½					−14·9	½						
4063			10·8	¼										
4045					−14·6	½			−11·8	½			−27·6	½
4005	−29·9	½	−14·8	½										
Weighted mean	− 28·12		− 21·65		− 26·18		− 21·42		− 20·69		− 29·70		− 20·82	
V_a	− 13·32		− 14·88		− 15·82		− 16·46		− 18·07		− 20·59		− 21·81	
V_d	− ·08		− ·12		− ·13		− ·14		− ·25		− ·13		− ·13	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 41·8		− 36·9		− 42·4		− 38·3		− 39·3		− 50·7		− 43·0	

MEASURES OF δ SERPENTIS—*Concluded*

λ	5619		5631		5638		5644		5961		6234		6803	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	−27·5	½					−31·3	½	−46·4	½	−20·2	½		
4481	20·0	½					14·6	½	34·2	½	3·7	¾	−27·5	½
4443							33·3	¼						
4395									56·9	¼				
4375							4·0	½						
4352									64·8	½				
4340	17·8	½	−17·9	¾	−11·5	½			57·1	½	38·5	¾	67·9	¾
4325	10·9	½	+ 2·6	¼	26·9	½							71·9	¼
4289	8·9	1	−12·2	½			10·5	½					60·2	¼
4271					9·9	½	14·0	½						
4250									79·7	½				
4233							0·0	½			36·6	¼		
4227									54·6	½			47·5	½
4198					10·3	½			44·3	½				
4143													59·4	¼
4101			−22·1	½							58·3	¼	65·6	½
4063	31·8	½			22·0	½								
4045	−20·0	½	− 5·9	½	−17·9	½	−30·5	¼	68·0	½	31·8	¼	57·5	½
4005									−36·7	½	−18·2	¼	44·2	½
3933													−68·2	½
Weighted mean	− 18·22		− 13·20		− 16·42		− 15·20		− 53·49		− 25·97		− 56·44	
V_a	− 23·26		− 24·87		− 25·20		− 25·67		+ 25·16		− 25·30		+ 25·80	
V_d	− ·21		− ·19		− ·17		− ·19		+ ·15		− ·13		+ ·12	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 42·0		− 38·5		− 42·1		− 41·3		− 28·5		− 51·7		− 30·8	

Dominion Observatory
Ottawa
April, 1919.

MEASURES OF RADIAL VELOCITY OF χ SERPENTIS

BY W. E. HARPER, M.A.

(1900, $\alpha = 15^h 37^m \cdot 1$, $\delta = + 13° 10'$, mag. 5·26, type B9)

This star was announced a binary by Adams in the *Astrophysical Journal*, XXXV, p. 176, from three measures in 1911 giving a range from − 4 to + 36.

Thirty plates, taken mostly in 1914, have been measured without giving a clue to the period. While slightly greater negative velocities have been secured than Adams got, yet, there are no velocities anything like as positive as he secured. No doubt if the observations were continued long enough, high positive velocities would be chanced upon and a period could be found, but the star has been dropped, temporarily at least, from our list. Our measures would indicate that the velocity of the system is about zero.

The character of the spectrum can be inferred from the lines in the accompanying table. Many other lines were measured on the best plates, but to make the measures as uniform as possible, the results were based on these 10 alone. The lines λ 4215 and λ 4077 are unusually strong in this spectrum. These are two of the lines which Adams uses in his spectral parallax determinations.

LINES USED IN χ SERPENTIS

λ	n	Residual		λ	n	Residual	
		Num.	Alg.			Num.	Alg.
4549·766	15	8·6	+4·0	4215·668	19	8·3	−3·8
4481·400	21	7·2	+1·7	4161·698	9	6·4	+2·4
4340·634	15	7·2	−2·2	4077·885	17	8·0	+4·4
4325·939	6	8·4	+4·8	4045·975	7	8·2	+1·2
4233·328	12	7·4	−6·4	3933·825	8	8·2	−3·6

SUMMARY OF MEASURES OF x SERPENTIS

Plate	Date, G.M.T.	Lines	Velocity
	1914		
5962	Feb. 23·915	6	+ 1·4
5981	Mar. 16·800	9	− 0·7
5991	" 20·859	5	− 8·2
5998	" 24·893	3	−15·4
6002	" 30·825	8	− 1·9
6005	" 31·826	4	+15·6
6012	April 3·813	7	− 4·6
6019	" 6·798	6	− 6·8
6027	" 12·802	6	− 0·5
6043	" 22·782	6	− 5·0
6057	May 1·807	4	+ 0·1
6069	" 8·811	7	+ 7·4
6079	" 24·699	4	−14·9
6083	" 28·675	1	+15·0
6089	June 4·670	4	− 4·4
6092	" 5·677	4	+ 8·5
6100	" 8·684	1	−12·1
6114	" 17·711	6	− 7·4
6120	" 19·660	7	+ 7·6
6134	" 26·702	10	− 1·8
6141	July 2·709	1	−12·4
6144	" 3·651	7	− 2·2
6167	" 9·635	3	+ 2·3
6190	" 16·669	2	+10·0
	1915		
6755	Jan. 28·929	5	+17·3
6793	Feb. 17·881	6	+ 8·9
6802	" 18·840	8	+12·5
6832	Mar. 3·850	6	− 0·6
6840	" 4·839	8	+ 1·9
	1916		
7783	Aug. 15·568	6	+15·2

MEASURES OF κ SERPENTIS

λ	5962		5981		5991		5998		6002		6005		6012	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549			−21·5	¼									−23·5	¾
4481	−22·6	1	21·9	¾	−33·9	1			−20·3	½	−24·9	1	32·6	1
4340			10·5	¼	26·9	1			23·6	¾			17·2	¾
4325					35·3	¾					39·7	¾	7·9	¾
4233	18·6	½	1·2	½					1·6	¾	34·0	1		
4215	7·2	¾	23·3	1			−39·7	¾	20·7	½	−20·1	¼	5·2	¼
4161	22·6	½	33·4	½			36·1	¼	22·0	¾				
4077	30·6	½	32·7	¾			−22·1	½	25·8	½			8·2	¾
4045	−37·8	¾	8·9	½	19·8	¾			22·4	½				
3933			−22·3	¾	−20·6	1			− 6·1	¼			−30·0	¾
Weighted mean	− 23·05		− 21·09		− 27·30		− 33·20		− 17·90		− 31·30		− 19·18	
V_a	+ 24·66		+ 20·51		+ 19·33		+ 18·16		+ 16·23		+ 15·91		+ 14·83	
V	+ ·04		+ ·14		+ ·02		− ·09		+ ·02		+ ·02		+ ·02	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 1·4		− 0·7		− 8·2		− 15·4		− 1·9		− 15·6		− 4·6	

λ	6019		6027		6043		6057		6069		6079		6083	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549			− 5·0	¾	− 8·4	½	−24·6	¼	+21·4	½	−16·5	½		
4481			−28·7	½	−28·8	¾	+ 6·3	½	−12·0	½	+ 4·5	½	+23·0	¾
4340	− 8·9	½	−27·5	½	−13·6	½			+18·4	½				
4233			− 1·3	½							− 5·6	½		
4215	11·7	¾	+ 3·4	1	− 4·2	½			+ 4·8	½				
4161	31·2	½			+ 1·3	½			− 4·6	¼				
4077	34·6	½	−20·7	1	−11·2	¾	− 9·2	½	− 7·2	½	−25·8	¼		
4045	22·6	¾												
3933	−15·6	½					+ 1·6	¾	+23·6	½				
Weighted mean	− 20·30		− 11·70		− 12·14		− 3·20		+ 7·20		− 8·74		+ 23·00	
V_a	+ 13·75		+ 11·47		+ 7·45		+ 3·65		+ 0·66		− 6·04		− 7·66	
V_d	+ ·04		·00		·00		− ·09		− ·14		+ ·15		− ·03	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 6·8		− 0·5		− 5·0		+ 0·1		+ 7·4		− 14·9		+ 15·0	

MEASURES OF χ SERPENTIS—*Concluded*

λ	6089		6092		6100		6114		6120		6134		6144	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	− 0·7	1			0·0	½	+ 4·7	½	+27·3	¼	−11·1	½	+18·0	½
4481	+ 4·5	¾	+17·6	1			− 2·5	½	19·0	¼	+14·0	¾	15·5	¾
4340			16·9	½			+19·5	¼	10·5	¼	+41·6	½	26·4	1
4325											+ 3·4	½	11·8	¾
4233			21·8	1			+11·0	½	27·4	½	+36·6	¾	18·1	½
4215	+20·6	¾	+22·0	½			+34·8	¼	22·2	½	+26·3	½	25·4	¼
4161											+12·8	¾		
4077	+ 1·8	½					+ 1·6	½	26·6	¼	+ 3·2	½	+10·8	½
4045									+30·0	¼	+ 9·0	½		
3933											+21·2	½		
Weighted mean	+ 6·30		+ 19·60		0·00		+ 8·44		+ 23·95		+ 16·42		+ 18·05	
V_a	− 10·41		− 10·80		− 11·85		− 15·11		− 15·83		− 17·80		− 19·84	
V_d	− ·02		− ·06		− ·07		− ·17		− ·09		− ·19		− ·14	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 4·4		+ 8·5		− 12·1		− 7·4		+ 7·6		− 1·8		− 2·2	

λ	6167		6190		6755		6793		6802		6832		6840	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	+24·4	½	+14·1	¾	− 3·3	½			+12·2	½	−22·6	½	−20·6	¾
4481	29·3	½	+52·2	¾	3·5	¾	−13·5	1	−22·5	½	23·1	½	6·7	¾
4340					11·7	¼	22·2	¾	−12·8	½	23·5	¼	24·5	½
4325							21·0	½	−44·4	¼	9·9	¼		
4233					4·2	1			− 8·0	¼	7·1	¼	43·1	½
4215	+17·9	½			−19·1	¾	19·0	1			−41·6	½	16·3	½
4161							11·0	½					24·8	¼
4077							−12·2	1	− 2·9	¼			24·8	¼
4045									+ 0·5	¼				
3933									−42·2	¼			−20·0	¾
Weighted mean	+ 23·87		+ 33·15		− 7·90		− 16·27		− 12·62		− 23·91		− 21·28	
V_a	− 21·26		− 22·67		+ 25·29		+ 25·30		+ 25·22		+ 23·48		+ 23·36	
V_d	− ·06		− ·22		+ ·14		+ ·12		+ ·19		+ ·11		+ ·12	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 2·3		+ 10·0		+ 17·3		+ 8·9		+ 12·5		− 0·6		+ 1·9	

Dominion Observatory
Ottawa
April, 1919.

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 21

MEASURES OF RADIAL VELOCITY OF κ CASSIOPEIÆ, g PERSEI, 69 TAURI AND ϵ CYGNI

BY W. E. HARPER, M.A.

MEASURES OF RADIAL VELOCITY OF κ CASSIOPEIÆ

(1900, $\alpha = 0^h\ 27^m{\cdot}3$, $\delta = +\ 62°\ 23'$, mag 4·24, type B)

This star was announced as a spectroscopic binary by Campbell, in *Lick Observatory Bulletin* No. 199, from 6 plates taken between 1902 and 1911, which showed a range in velocity of about 25 km.

Fifty-two plates were made here in 1913 and 1914 with the old single-prism spectrograph; those from plate 6184 to the end were made with the present arrangement having a dispersion of about 33 angstroms per millimetre at $H\gamma$. The hydrogen, helium and silicon lines are fair for a star of this type, but the measures upon them are not as accordant as could be desired. A table is given showing the data regarding these lines. The H and K lines of calcium are exceedingly good and the measures upon these two alone are about as reliable as upon all the rest put together. Their velocities are, however, more negative than those for the other lines. On the assumption of a constant velocity for the star, the weighted mean for the calcium lines on 51 plates, with a total weight of 107, is −16·77 km. per second, with a probable error for a plate of ± 4·45 km. per second. The corresponding velocity for the other lines on 50 plates, with a total weight of 115, is −3·02 km. per second. The extreme range in the case of the general lines is 59 km., while for the calcium lines it is only 34 km. A considerable amount of each may be regarded as fictitious owing to errors of measurement, but it would seem that this star is another example of the ever increasing class of spectroscopic binaries in which the displacements shown by the calcium absorption is much less than that for the other elements.

While there seems no doubt of the binary character of the star, the period has not yet been determined and the measures are published in case some one, who has not the equipment for observation, may wish to do some astronomical work by determining a period to fit the observations.

LINES MEASURED IN κ CASSIOPEIÆ

λ	Element	*n*	Wt.	Residual	
				Numerical	Algebraic
4567·967	*Si*	17	7¼	9·9	−5·8
4552·762	*Si*	27	10⅛	9·4	−5·8
4471·676	*He*	37	17	7·8	+0·7
4388·100	*He*	15	5¾	11·0	+5·0
4340·634	*H*	32	13⅝	13·0	+6·5
4143·928	*He*	14	5¾	13·8	−1·1
4116·330		5	2¼	8·1	+1·0
4101·890	*H*	35	11⅜	6·7	+2·8
4089·120		12	4½	11·7	−8·3
4026·352	*He*	29	10⅞	9·8	−2·1
3970·177	*H*	10	3⅛	8·9	−6·4

SUMMARY OF VELOCITIES OF κ CASSIOPEIÆ

Plate	Date	General Lines			*H* and *K*	
		Vel.	*n*	Wt.	Vel. + 13·8	Wt.
	1913					
5672	Sept. 15	+ 1·4	6	2¾	+ 2·8	2
5687	“ 22	+ 0·4	4	2½	+ 2·4	2½
5706	“ 26	− 6·2	5	3½	+ 0·7	2
5713	“ 29	− 4·5	3	1¾	+ 0·9	2
5730	Oct. 1	−14·6	3	1½	+ 2·5	2½
5738	“ 3	± 0·0	4	1	− 2·0	1
5744	“ 4	+ 2·5	3	1½	− 7·2	2½
5840	Dec. 22	+ 3·1	4	2¼	....	....
5859 a	“ 31	+17·0	5	2½	− 5·6	1½
5859 b	“ 31	+12·9	6	3¼	+ 1·0	1
	1914					
5876	Jan. 5	....	....	....	− 7·7	2
5881	“ 12	....	....	....	− 7·0	1½
6184	July 14	− 9·0	7	2¾	− 2·8	2
6199	“ 17	− 1·7	6	2¾	+ 0·7	1½
6217	“ 21	± 0·0	3	1¾	− 9·0	2
6271	Aug. 11	− 6·3	8	2¼	− 3·1	2
6277	“ 14	− 4·6	6	1½	−11·9	2
6288	“ 19	−17·0	8	2½	−18·4	2
6292	“ 21	−40·8	4	1¼	−10·2	3
6309	“ 25	−31·3	4	1¼	−23·8	2¼
6319	“ 27	+ 4·6	5	2	− 2·6	2
6329	“ 31	−25·5	6	2½	− 9·4	¾
6332	Sept. 2	− 0·3	6	2½	− 1·3	1½
6336	“ 4	+ 2·2	6	1	− 2·0	2¼
6341	“ 7	+ 2·8	5	1⅜	+ 1·4	3
6343	“ 8	−18·7	7	2¼	−11·4	2½
6357	“ 11	− 9·4	7	2¼	− 6·3	2¼
6361	“ 12	−22·0	5	1¾	− 6·4	2¼
6364	“ 13	+ 3·9	7	4	+ 1·1	1½
6365	“ 13	+ 9·8	7	3	+ 3·0	3
6370	“ 14	−13·6	6	2¼	− 3·4	2
6377	“ 15	+12·4	9	3¼	+ 3·8	5
6383	“ 16	+11·6	6	2¾	− 6·8	2¼
6391	“ 17	−11·7	4	1¾	− 4·2	2½
6399	“ 18	+13·0	8	3	+10·3	1
6406	“ 19	− 5·1	10	5¼	− 4·2	2½
6416	“ 21	+10·8	6	1¾	−15·4	2¼
6427	“ 25	− 6·0	5	2½	− 7·0	2¼
6433	“ 27	−21·7	5	1¾	− 2·8	2¼
6440	“ 28	+ 1·0	5	2¾	− 1·0	2
6447	“ 30	− 9·8	8	3½	− 2·0	2¼
6455	Oct. 1	− 8·1	4	1	− 3·5	2
6464	“ 2	− 3·6	6	1½	+ 3·3	1½
6480	“ 4	− 3·8	4	1¾	+ 8·2	1¾
6499	“ 13	− 5·6	4	1¼	− 0·3	1½
6513	“ 21	− 5·0	7	2½	+ 7·3	1¾
6520	“ 22	+ 2·6	6	3	+ 7·0	2½
6529	“ 23	+ 8·8	5	2½	+ 9·9	2
6535	“ 28	−23·0	6	2½	− 9·9	2¼
6543	Nov. 2	−12·5	3	1	− 3·6	2
6553	“ 4	−19·0	4	2	− 4·0	2¼
6555	“ 14	+ 5·0	7	4¼	− 6·0	3

VELOCITIES OF THE *H* AND *K* LINES

Plate	Vel. *H* 3968·625	Wt.	Vel. *K* 3933·825	Wt.	Weighted Mean	Reduction to Sun	Radial Velocity
5672	−24·4	1	−23·7	1	−24·05	+13·10	−11·0
5687	−19·7	1½	−27·9	1	−23·00	+11·56	−11·4
5706	−20·0	1	−27·2	1	−23·60	+10·52	−13·1
5713	−24·8	1	−20·7	1	−22·75	+ 9·83	−12·9
5730	−13·7	1	−25·2	1½	−20·60	+ 9·35	−11·3
5738	−23·3	½	−25·7	½	−24·50	+ 8·73	−15·8
5744	−28·1	1	−30·5	1½	−29·54	+ 8·53	−21·0
5859 a	− 4·7	½	− 2·6	1	− 3·31	−16·14	−19·4
5859 b	+ 5·0	½	+ 1·6	½	+ 3·30	−16·14	−12·8
5876	− 2·8	1	− 6·3	1	− 4·55	−16·94	−21·5
5881	− 2·7	½	− 2·8	1	− 2·77	−18·07	−20·8
6184	−32·5	1	−34·1	1	−33·30	+16·74	−16·6
6199	−32·0	¾	−28·1	¾	−30·05	+16·94	−13·1
6217	−41·6	1	−38·6	1	−40·10	+17·31	−22·8
6271	−42·5	½	−31·8	1½	−34·48	+17·57	−16·9
6277	−38·8	1	−47·3	1	−43·05	+17·35	−25·7
6288	−50·4	1	−47·9	1	−49·15	+16·99	−32·2
6292	−41·3	1½	−40·7	1½	−41·00	+16·99	−24·0
6309	−52·9	¾	−54·8	1½	−54·17	+16·53	−37·6
6319	−35·8	1¼	−27·6	¾	−32·75	+16·40	−16·4
6329	−39·1	¾	....	....	−39·10	+15·85	−23·2
6332	−26·1	¾	−35·4	¾	−30·75	+15·63	−15·1
6336	−23·1	¾	−34·9	1½	−30·97	+15·22	−15·8
6341	−27·0	1¼	−27·4	1¾	−27·23	+14·79	−12·4
6343	−36·4	1¼	−43·3	1¼	−39·85	+14·66	−25·2
6357	−39·8	¾	−31·8	1½	−34·47	+14·35	−20·1
6361	−40·9	¾	−30·8	1½	−34·17	+13·98	−20·2
6364	−32·6	½	−23·4	1	−26·47	+13·73	−12·7
6365	−26·0	1¼	−23·4	1¾	−24·48	+13·72	−10·8
6370	−30·1	1	−31·3	1	−30·70	+13·46	−17·2
6377	−21·9	2½	−24·6	2½	−23·25	+13·28	−10·0
6383	−31·1	¾	−35·0	1½	−33·70	+13·10	−20·6
6391	−28·0	1	−32·9	1½	−30·92	+12·87	−18·0
6399	−13·6	¾	−19·7	¼	−15·12	+12·62	− 3·5
6406	−29·0	1	−31·2	1½	−30·32	+12·34	−18·0
6416	−37·8	¾	−42·7	1½	−41·07	+11·89	−29·2
6427	−29·4	¾	−32·9	1½	−31·73	+10·94	−20·8
6433	−28·2	¾	−26·4	1½	−27·00	+10·36	−16·6
6440	−17·4	½	−27·5	1½	−25·00	+10·23	−14·8
6447	−30·7	¾	−23·1	1½	−25·63	+ 9·79	−15·8
6455	−26·9	¾	−26·8	1¼	−26·84	+ 9·58	−17·3
6464	−15·8	½	−21·9	1	−19·87	+ 9·36	−10·5
6480	− 9·9	1	−20·2	¾	−14·30	+ 8·69	− 5·6
6499	−28·5	½	−15·9	1	−20·10	+ 6·03	−14·1
6513	− 8·6	¾	−11·4	1	−10·20	+ 3·72	− 6·5
6520	− 4·5	1	−14·2	1½	−10·32	+ 3·52	− 6·8
6529	−12·3	½	− 5·3	1½	− 7·05	+ 3·18	− 3·9
6535	−25·3	¾	−25·0	1½	−25·10	+ 1·38	−23·7
6543	−15·7	¾	−18·2	1¼	−17·30	− 0·10	−17·4
6553	−17·0	1	−17·0	1¼	−17·00	− 0·84	−17·8
6555	−17·2	1¼	−15·0	1¾	−15·92	− 3·93	−19·8

MEASURES OF κ CASSIOPEIÆ

λ	5672 Vel.	5672 Wt.	5706 Vel.	5706 Wt.	5713 Vel.	5713 Wt.	5730 Vel.	5730 Wt.	5738 Vel.	5738 Wt.	5744 Vel.	5744 Wt.	5840 Vel.	5840 Wt.
4567											− 8·3	½		
4552	−19·7	½	−42·0	½										
4471	16·7	½	17·3	1	−10·7	½	−18·1	½	−10·2	¼	+ 4·6	½	+21·4	½
4388	0·0	½											20·9	½
4340	7·2	½	8·8	1			40·4	½	−18·1	¼	−14·6	½	2·2	¾
4143	3·0	¼	21·6	½										
4101					12·3	¾			−15·4	¼			+32·3	½
4026	−19·2	½	− 1·2	½	−21·0	½	−13·5	½	+ 9·0	¼				
Weighted mean	− 11·67		− 16·71		− 14·33		− 24·00		− 8·70		− 6·00		+ 17·24	
V_a	+ 13·41		+ 10·91		+ 10·15		+ 9·66		+ 9·11		+ 8·84		− 13·79	
V_d	− ·03		− ·11		− ·04		− ·03		− ·10		− ·03		− ·11	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 1·4		− 6·2		− 4·5		− 14·6		± ·0·0		+ 2·5		+ 3·1	

MEASURES OF κ CASSIOPEIÆ—*Continued*

λ	5859 a Vel.	5859 a Wt.	5859 b Vel.	5859 b Wt.	6184 Vel.	6184 Wt.	6199 Vel.	6199 Wt.	6217 Vel.	6217 Wt.	6271 Vel.	6271 Wt.	6277 Vel.	6277 Wt.
4567			+21·9	½	−13·3	¼			− 9·2	¾				
4552			43·1	½	32·7	½	−11·9	½			− 5·9	¼	−10·9	¼
4471	+51·0	½	33·8	¾	24·0	¼	15·8	¾	23·5	½	24·6	½	−42·6	¼
4388			47·0	½	37·2	½					19·8	¼		
4340	36·5	½					40·7	½			34·0	¼	−40·2	¼
4143	13·5	½	18·7	½									−25·4	¼
4116					16·5	¾								
4101	23·8	½			39·1	¼	16·1	½	−23·2	½	25·8	¼	−21·4	¼
4089	+41·1	½					5·7	¼			14·6	¼	+ 9·2	¼
4026			+ 7·3	½	−17·4	¼	−13·9	¼			34·0	¼		
3970											−31·6	¼		
Weighted mean	+ 33·18		+ 29·02		− 25·71		− 18·62		− 17·26		− 23·87		− 21·90	
V_a	− 15·76		− 15·76		+ 16·91		+ 17·18		+ 17·50		+ 17·81		+ 17·66	
V_d	− ·10		− ·10		+ ·11		+ ·04		+ ·09		+ ·04		− ·03	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 17·0		+ 12·9		− 9·0		− 1·7		± 0·0		− 6·3		− 4·6	

MEASURES OF κ CASSIOPEIÆ—*Continued*

λ	6288 Vel.	Wt.	6292 Vel.	Wt.	6309 Vel.	Wt.	6319 Vel.	Wt.	6329 Vel.	Wt.	6332 Vel.	Wt.	6336 Vel.	Wt.
4567			−56·4	½	−41·5	½			−32·6	½				
4552	−30·5	¼									−22·9	½		
4471	39·8	¼			43·8	¼	−29·5	¼	22·3	½			−11·8	¼
4388	19·4	¼							30·8	¼	−36·8	½	−25·8	¼
4340	49·2	¼	74·5	¼	58·9	¼	−10·1	¼	68·9	½	− 3·0	¼	−19·3	⅛
4143	20·1	½					−11·8	¾						
4101	48·7	¼					−30·4	¼	49·6	½	−27·8	¼	− 4·0	⅛
4089											+ 4·4	½		
4026	40·8	½	44·2	¼			+ 5·4	⅛			− 9·0	½	− 9·4	⅛
3970	−30·3	¼	−57·6	¼	−53·3	¼			−36·0	¼			+ 3·5	⅛
Weighted mean	− 33·97		− 57·82		− 47·80		− 11·80		− 41·32		− 15·90		− 13·05	
V_a	+ 17·31		+ 17·17		+ 16·77		+ 16·57		+ 16·17		+ 15·81		+ 15·45	
V_d	− ·04		+ ·10		+ ·04		+ ·11		− ·04		+ ·10		+ ·05	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 17·0		− 40·8		− 31·3		+ 4·6		− 25·5		− 0·3		+ 2·2	

MEASURES OF κ CASSIOPEIÆ—*Continued*

λ	6341 Vel.	Wt.	6343 Vel.	Wt.	6357 Vel.	Wt.	6361 Vel.	Wt.	6364 Vel.	Wt.	6365 Vel.	Wt.	6370 Vel.	Wt.
4567					−19·8	¼			+13·0	½	+33·1	¼	−14·8	½
4552	−22·0	⅛	−48·0	¼	15·4	¼			−12·8	½	− 3·9	¼	18·8	¼
4471	12·7	¼	36·5	½	29·1	½	−36·3	¼	−12·4	¾	0·0	½	57·3	½
4388			14·8	¼					−27·0	¾				
4340	1·6	½	28·2	½	29·5	¼	32·8	½			−48·6	½	41·6	¼
4143					32·9	¼					+30·0	½		
4116							42·8	½						
4101	10·5	¼	41·7	¼			32·8	¼	−22·5	¼	+ 6·6	½	34·6	¼
4089			24·3	¼					− 7·2	¾				
4026	−28·7	¼	−41·2	¼	20·9	¼	−31·8	¼	+ 2·2	½	−26·3	½	− 2·4	½
3970					−18·4	½								
Weighted mean	− 12·00		− 33·38		− 23·70		− 36·00		− 9·82		− 3·95		− 27·06	
V_a	+ 14·97		+ 14·81		+ 14·63		+ 14·10		+ 13·88		+ 13·88		+ 13·67	
V_d	+ ·10		+ ·13		·00		+ ·16		+ ·13		+ ·12		+ ·07	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 2·8		− 18·7		− 9·4		− 22·0		+ 3·9		+ 9·8		− 13·6	

MEASURES OF κ CASSIOPEIÆ—*Continued*

λ	6377		6383		6391		6399		6406		6416		6427	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4567	+15·3	¼	−15·2	½										
4552	− 3·2	½	+22·8	½	−11·9	½	+21·2	¼	− 7·0	1	+17·3	¼		
4471	+ 8·2	½	− 6·8	¼	34·7	½	+12·2	½	25·6	½			−17·6	½
4388	− 1·0	¼	−15·1	½			−24·4	¼	20·3	¾	+ 6·0	¼		
4340	− 6·4	½	+ 0·4	½	12·8	¼	− 5·0	½	26·7	¾	− 1·3	¼	−39·6	½
4143	−16·3	¼							23·9	¼	−13·0	¼	+ 2·4	½
4116					−33·1	½			7·4	¼				
4101	+ 2·8	¼	+ 2·4	½			− 1·6	¼	19·9	½	+12·7	¼	−21·9	½
4089	+ 1·1	¼					− 7·5	¾	23·8	¼				
4026	− 5·3	½					− 5·2	¼	14·5	¾	−15·1	½	− 8·2	½
3970							+22·8	¼	− 6·7	¼				
Weighted mean	− 0·86		− 1·45		− 24·60		+ 0·37		− 17·41		− 1·14		− 16·98	
V_a	+ 13·46		+ 13·25		+ 13·01		+ 12·79		+ 12·57		+ 12·13		+ 11·20	
V_d	+ ·10		+ ·13		+ ·14		+ ·11		+ ·05		+ ·04		+ ·02	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 12·4		+ 11·6		− 11·7		+ 13·0		− 5·1		+ 10·8		− 6·0	

MEASURES OF κ CASSIOPEIÆ—*Continued*

λ	6433		6440		6447		6455		6464		6480		6499	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4567			− 19·3	½	− 20·9	¼								
4552	− 50·0	¼							− 14·7	¼			− 4·5	¼
4471	29·7	½	− 12·4	½	− 31·4	¾	− 9·7	¼	− 1·2	¼	− 20·3	½	6·2	½
4388					− 2·6	¼								
4340			+ 3·4	¾	− 33·1	½	28·1	¼	− 33·6	¼	− 3·7	½		
4143													26·1	¼
4101	27·9	¼	− 6·6	½	− 31·4	¼	20·4	¼	− 41·1	¼	− 20·4	½	− 15·1	¼
4089	25·7	½			+ 10·5	¼								
4026	− 35·6	¼	− 17·6	½	− 20·8	½	− 12·6	¼	+ 17·8	¼	+ 1·5	¼		
3970					− 9·1	¾			− 4·8	¼				
Weighted mean	− 32·05		− 9·20		− 19·55		− 17·70		− 12·93		− 12·46		− 11·60	
V_a	+ 10·73		+ 10·50		+ 10·04		+ 9·81		+ 9·52		+ 8·94		+ 6·34	
V_d	− ·09		+ ·01		+ ·03		+ ·05		+ ·12		+ ·03		− ·03	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 21·7		+ 1·0		− 9·8		− 8·1		− 3·6		− 3·8		− 5·6	

MEASURES OF κ CASSIOPEIÆ—*Concluded*

λ	6513		6520		6529		6535		6543		6553		6555	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4567	+ 3·3	¼			+ 7·1	¾	−14·7	¼					+ 1·2	½
4552	+ 1·6	¼	+17·0	½			24·3	½	− 8·8	¼	−13·3	½	+12·2	¾
4471	−29·5	½	+ 4·6	1	+ 9·4	½	14·5	¼	18·0	½	18·0	¾	+23·6	¾
4388													+ 6·2	½
4340	−16·8	½	−25·3	½	+11·4	½	39·4	¾					+27·0	½
4143	+ 9·0	½	− 9·6	½							32·3	¼	−12·3	¾
4116	−11·3	½												
4101	− 6·2	¼	− 5·3	¼	−15·5	¼			− 4·7	¼	−16·2	½	+ 6·2	½
4089							1·0	¼						
4026			+11·4	¼	+ 4·2	½	−23·3	½						
Weighted mean	− 8·72		− 0·93		+ 5·60		− 24·36		− 12·40		− 18·16		+ 8·92	
V_a	+ 4·00		+ 3·68		+ 3·36		+ 1·78		+ 0·25		− 0·42		− 3·56	
V_d	·00		+ ·12		+ ·10		− ·12		− ·07		− ·14		− ·09	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 5·0		+ 2·6		+ 8·8		− 23·0		− 12·5		− 19·0		+ 5·0	

Dominion Observatory
Ottawa
April, 1919.

MEASURES OF RADIAL VELOCITY OF *g* PERSEI

BY W. E. HARPER, M.A.

(1900, $\alpha = 1^h\ 55^m \cdot 6$, $\delta = +54° 01'$, mag 4·99, type B8)

This star was announced as a spectroscopic binary by Frost and Adams, in *Astrophysical Journal*, vol. XIX, page 352, from 4 measures in 1903 and 1904, giving a range from −24 to +10. Later, Lee published 5 measures of plates taken in 1907 and 1908 in the same journal, vol. XXXIX, page 44, without increasing the range. Adams and Kapteyn also give a velocity of +12 from 1 plate in the same journal, vol. XXVII, page 188.

Sixteen plates were secured here in 1910 and 1911, and then the star was dropped from our list as it was learned that the Allegheny observatory had it on their list and were working up its orbit.

The plates on the whole are not of as good quality as could be obtained, but the measures should be approximately correct. On some of the plates, the lines have the appearance of being doubled, there apparently being a red component to the hydrogen lines about +105 km. per sec. for plate 4561. Our measures indicate a slightly greater range than previously recorded.

OTTAWA MEASURES OF *g* PERSEI

Plate	Date, G.M.T.	Vel.	n	Wt.	Remarks
3720	1910, Oct. 7·816	−27	6	3¾	
3727	" 10·777	−15	3	1	
4401	1911, June 29·836	−18	5	2½	
4491	Aug. 14·819	+ 8	3	⅞	
4513	" 30·871	+ 5	2	2	
4541	Sept. 12·768	− 4	1	½	4481 gives +59
4551	" 13·835	+19	3	1¼	
4561	" 17·778	+ 4	4	3¾	4481 gives +38
4568	" 18·867	+17	3	1¾	
4576	" 19·751	+ 9	3	1¼	
4592	" 22·808	+23	3	1½	
4593	" 23·729	+15	4	2¼	
4616	Oct. 9·786	− 1	4	2½	
4643	" 13·696	− 9	3	⅞	
4668	" 27·784	± 0	2	1	
4683	Nov. 3·628	−26	5	3	

MEASURES OF *g* PERSEI

λ	3720		3727		4401		4491		4513		4541		4551	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	−41·0	½	....	.....	−43·8	½	....	.....	....	.....	....	.....	....	.....
4481·400	28·4	¾	−10·6	¼	24·6	½	....	.....	....	.....	....	.....	+15·1	½
4340·634	42·0	¾	23·1	¼	31·8	½	−16·1	½	−18·2	1	−23·0	½	−14·5	½
4101·890	24·0	¼	....	.....	34·4	½	+ 6·6	¼	....	.....	....	.....	− 2·6	¼
4026·352	54·9	¼	....	.....	....	.....	....	.....	−14·9	1	....	.....	....	.....
3933·825	−35·2	¾	−35·5	½	−42·0	½	−35·1	⅛	....	.....	....	.....	....	.....
Weighted mean	− 39·17		− 26·18		− 35·32		− 14·33		− 16·55		− 23·00		− 0·24	
V_a	+ 12·81		+ 11·82		+ 17·08		+ 22·80		+ 21·68		+ 19·59		+ 19·38	
V_d	− ·10		− ·04		+ ·19		+ ·09		·00		+ ·06		− ·03	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 26·7		− 14·7		− 18·3		+ 8·3		+ 4·9		− 3·6		+ 18·8	

MEASURES OF *g* PERSEI—*Continued*

λ	4561		4568		4576		4592		4593		4616		4643	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	....	.....	+ 9·7	¼	....	.....	....	.....	....	.....	....	.....	....	.....
4481·400	....	.....	− 2·5	¾	−20·6	½	+10·1	½	− 1·9	1	− 8·3	1	−24·9	½
4471·676	....	.....	....	.....	−13·4	¼	....	.....	....	.....	....	.....	....	.....
4340·634	− 9·8	1	− 2·6	¾	+ 4·2	½	3·1	½	− 5·8	¼	13·4	½	15·1	¼
4101·890	22·5	1	....	.....	....	.....	+ 3·6	½	− 1·0	½	18·5	½	−10·1	⅛
4026·352	−31·0	¾	....	.....	....	.....	....	.....	....	.....	....	.....	....	.....
3933·825	0·0	1	....	.....	....	.....	....	.....	+ 2·8	½	−15·4	½	....	.....
Weighted mean	− 14·80		− 0·74		− 9·20		+ 5·60		− 1·44		− 12·76		− 20·00	
V_a	+ 18·52		+ 18·26		+ 18·05		+ 17·29		+ 17·06		+ 12·24		+ 10·90	
V_d	+ ·03		− ·05		+ ·04		− ·02		+ ·09		− ·04		+ ·04	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 3·5		+ 17·2		+ 8·6		+ 22·6		+ 15·4		− 0·8		− 9·3	

MEASURES OF *g* PERSEI—*Concluded*

λ	4668		4683											
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481·400			−41·2	1										
4340·634	− 7·3	½	17·6	½										
4101·890			10·3	½										
4026·352			23·4	½										
3933·825	− 3·0	½	−41·4	½										
Weighted mean	− 5·15		− 28·27											
V_a	+ 5·66		+ 2·95											
V_d	− ·10		+ ·04											
Curv.	− ·28		− ·28											
Radial Velocity	+ 0·1		− 25·6											

Dominion Observatory
Ottawa
April, 1919.

MEASURES OF RADIAL VELOCITY OF 69 TAURI

BY W. E. HARPER, M.A.

(1900, $\alpha = 4^h\ 20^m{\cdot}3$, $\delta = +22°\ 35'$, mag. 4.40, type A5)

This star was announced a spectroscopic binary by Frost, in the *Astrophysical Journal*, volume XXIX, page 238, from 5 plates taken in 1905, 1908 and 1909. He stated that the spectrum was a very difficult one to deal with, owing to the diffuse and complex character of the lines. In the hope of obtaining measures of the component spectra, the star was placed upon our list and some twenty odd plates secured in 1910,1911, 1912 and 1913, of which 22 are given in the accompanying table. All but those in December, 1913, were made with the old single-prism spectrograph, whose dispersion at $H\gamma$ is 32·4 angstroms per millimetre; those in December, 1913, were made with camera Ia, whose dispersion is 54·5 angstroms per millimetre. To say that we have confirmed Frost's statement that it is a very difficult spectrum to deal with, would seem to sum up about all that we can say about the star. However, on plate 4646 the lines are much sharper than usual and numerous metallic lines, other than those appearing in the measures, are recorded whose velocities agree with those from the other lines. It would seem that the component spectra are superposed on this date, so that these fainter lines, which in general show no trace, are here of sufficient contrast to be measurable. Thus, it would appear that the velocity of the system must be in the neighbourhood of that given by this plate, namely, +50 km. per sec. The prevailing tendency to high positive velocities of the other plates bear this out. The star might possibly be worked up by using higher dispersion and fine-grained plates, attention being paid only to the metallic lines.

OTTAWA MEASURES OF 69 TAURI

Plate	Date	Vel.	Lines	Remarks
3659	1910, Sept. 15·902	+40	1	plate underexposed.
3669	" 16·836	− 6	2	
3834	Dec. 8·604	+14	3	
3891	" 21·804	+ 3	1	
3904	" 30·578	+21	2	
3923	1911, Jan. 9·664	+76	3	very poor lines.
3937	" 16·628	+58	4	
4618	Oct. 9·903	+80	1	
4635	" 12·812	+77	1	
4646	" 13·840	+50	9	much sharper lines than usual.
4708	Dec. 3·812	+41	2	
4730	" 19·633	+38	2	
5198	1912, Sept. 16·846	+15	3	
5211	Oct. 1·753	+55	2	poor plate.
5760	1913, Oct. 7·853	−27	2	components +60 and −106.
5789	Nov. 4·798	+27	3	
5796	" 5·795	+58	3	
5816	Dec. 8·737	+20	3	
5825	" 13·685	+59	3	
5847	" 22·740	+25	3	
8385	1917, Dec. 15·545	+22	1	
8398	" 28·627	+ 9	1	

MEASURES OF 69 TAURI

λ	3659 Vel.	3659 Wt.	3669 Vel.	3669 Wt.	3834 Vel.	3834 Wt.	3891 Vel.	3891 Wt.	3904 Vel.	3904 Wt.	3923 Vel.	3923 Wt.	3937 Vel.	3937 Wt.
4861·527													+97·4	⅛
4481·400					+17·0	¼								
4340·634	+11·5	¼	−42·2	¼	15·8	½	+14·7	¼	+43·1	¼	+80·0	⅛	81·0	¼
4271·760											110·0	⅛		
4236·107			−27·1	¼										
4101·890													51·1	⅛
4045·975									+30·0	¼	+100·0	⅛		
3933·825					+22·6	¼							+87·8	¼
Weighted mean	+ 11·54		− 34·65		+ 19·40		+ 14·70		+ 36·55		+ 96·67		+ 81·02	
V_a	+ 28·70		+ 28·28		− 4·89		− 11·59		− 15.68		− 20·01		− 22·62	
V_d	·00		+ ·12		+ ·12		− ·26		+ ·09		− ·09		− ·11	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 40·0		− 6·5		+ 14·4		+ 2·6		+ 20·7		+ 76·3		+ 58·0	

MEASURES OF 69 TAURI—*Continued*

λ	4618 Vel.	4618 Wt.	4635 Vel.	4635 Wt.	4646 Vel.	4646 Wt.	4708 Vel.	4708 Wt.	4730 Vel.	4730 Wt.	5198 Vel.	5198 Wt.	5211 Vel.	5211 Wt.
4861·527					+40·2	½	+38·7	¼	+56·2	¼	−23·5	⅛	+55·6	⅛
4481·400					40·6	½								
4340·634	+56·7	¼	+55·0	¼	28·1	1	+48·5	¼	+41·1	¼	−33·5	¼	+ 4·2	¼
4233·328					23·6	½								
4227·010					31·3	½								
4143·928					35·8	½								
4101·890					19·3	½					+20·1	⅛		
4045·975					20·7	¼								
3933·825					+ 4·2	¼								
Weighted mean	+ 56·70		+ 55·00		+ 28·80		+ 43·63		+ 48·65		− 12·63		+ 29·90	
V_a	+ 22·94		+ 21·90		+ 21.62		− 2·24		− 10·39		+ 28·21		+ 25·05	
V_d	+ ·11		+ ·04		− ·04		− ·21		+ ·04		+ ·10		+ ·12	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 79·5		+ 76·7		+ 50·1		+ 40·9		+ 38·0		+ 15·4		+ 54·8	

MEASURES OF 69 TAURI—*Concluded*

λ	5760		5789		5796		5816		5825		5847		8385	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	−75·3	⅛	+21·3	¼	+61·0	¼	.....	.....	.....	.....	.....	.....	.....	.....
4481·400	.....	.....	.....	.....	.....	.....	.....	.....	+57·2	¼	+28·6	¼	.....	.....
4340·634	−37·8	¼	+20·0	½	44·6	½	+29·6	¼	.....	.....	40·0	¼	+31·2	¼
4101·890	.....	.....	.....	.....	.....	.....	21·0	¼	84·1	¼	.....	.....	.....	.....
3933·825	.....	.....	− 2·1	¼	+34·7	¼	+25·1	½	+58·3	¼	+44·3	¼	.....	.....
Weighted mean	− 50·30		+ 14·80		+ 46·22		+ 25·20		+ 66·53		+ 37·63		+ 31·20	
V_a	+ 23·43		+ 12·30		+ 11·83		− 5·06		− 7·64		− 12·16		− 8·58	
V_d	·00		− ·06		− ·06		− ·10		− ·04		− ·18		+ ·17	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 27·2		+ 26·8		+ 57·7		+ 19·8		+ 58·6		+ 25·0		+ 22·5	

Dominion Observatory
Ottawa
April, 1919.

MEASURES OF RADIAL VELOCITY OF ϵ CYGNI

BY W. E. HARPER, M.A.

(1900, $\alpha = 20^h\ 42^m \cdot 2$, $\delta = +33° 36'$, mag. 2·64, type K)

This star was announced a spectroscopic binary by Curtis and Burns in *Lick Observatory Bulletin* 107. Their 7 plates show a range of about 7 km. Lord published 5 velocities in *Astrophysical Journal*, XXI, 319, showing a range of 4·4 km. with a mean value of −13·0 km. per sec. Campbell uses −10 km. per sec. for his statistical treatment of K-type stars. Küstner gives 6 measures in *Astrophysical Journal*, XXVII, 319, in which a range of 9·1 km. is shown.

Fifty plates were made here during the years 1907, 1908, 1909, 1914 and 1915, with the three-prism spectrograph, III L, which has a dispersion at λ 4415 of 10·1 angstroms per millimetre. The star has excellent lines for measurement, and as 15 or 20 were measured on each plate the results should be fairly reliable. The extreme range shown by our measures is from −4·5 to −14·6 km., but, apart from a few such plates, no great range is shown in the measures. The mean velocity, on the assumption of a constant velocity for the star, using the 50 plates with equal weights is −10·0 km. per sec. The residuals from this mean value follow the probability curve fairly closely and yield a probable error for a plate of ± 1·47 km. per sec., a value somewhat higher than might be expected from the good quality of the lines. If the 1914 and 1915 plates alone are used, —and they number 41 out of the 50—there is a reasonable appearance of the observations falling into a curve whose period is 19·664 days and range 5 km. Barring the plate of Aug. 4, 1914, (a memorable date) a considerable reduction in the probable error is effected. Five of the Lick observations are thereby satisfied but the first two are discordant.

While no doubt a small range exists, a satisfactory period has not yet been obtained. The measures are published so that if others should wish to attempt a period the data will be available to them.

OTTAWA MEASURES OF ϵ CYGNI

Plate	Date	Julian Date	Vel.	Plate	Date	Julian Date	Vel.
1163	1907, Nov. 29	2,417,909·48	− 8·2	6039	1914, Apr. 17	2,420,240·84	−12·0
1172	Dec. 4	914·54	9·1	6087	May 30	283·85	8·7
1186	" 12	922·52	10·3	6107	June 13	297·85	11·1
1210	1908, Jan. 3	944·45	8·5	6149	July 5	319·70	4·5
1556	May 25	2,418,087·85	9·0	6170	" 9	323·81	7·9
1618	June 20	113·77	13·7	6181	" 14	328·62	13·1
1795	Aug. 19	173·76	14·5	6194	" 16	330·84	13·7
2735	1909, Aug. 10	529·63	7·6	6208	" 19	333·79	9·6
2736	" 10	529·69	− 8·5	6213	" 21	335·60	− 8·8

OTTAWA MEASURES OF ε CYGNI—*Continued*

Plate	Date	Julian Date	Vel.	Plate	Date	Julian Date	Vel.
6225	1914, July 25	2,420,339·72	− 5·9	7065	1915, June 17	2,420,666·81	−12·7
6229	" 28	342·83	7·9	7070	" 20	669·79	10·1
6237	" 30	344·71	10·0	7086	July 1	680·84	8·1
6240	Aug. 1	346·68	12·1	7094	" 9	688·80	11·7
6259	" 4	349·76	7·6	7095	" 10	689·68	7·7
6278	" 15	360·68	8·9	7097	" 12	691·81	10·9
6282	" 18	363·81	6·6	7100	" 13	692·80	10·3
6297	" 22	367·70	12·4	7106	" 17	696·68	11·5
6298	" 24	369·54	9·1	7107	" 19	698·59	10·1
6320	" 27	372·75	8·9	7114	" 20	699·84	11·3
6325	" 31	376·56	8·4	7117	" 22	701·84	14·6
6334	Sept. 4	380·55	7·1	7120	" 23	702·86	11·8
6347	" 9	385·54	11·2	7121	" 26	705·58	11·6
6393	" 17	393·68	8·1	7131	" 29	708·58	10·9
6534	Oct. 27	433·53	10·6	7136	Aug. 1	711·67	9·7
7056	1915, June 8	657·83	−10·5	7142	" 8	718·66	−12·0

MEASURES OF ε CYGNI

λ	1172 Vel.	1172 Wt.	1210 Vel.	1210 Wt.	1556 Vel.	1556 Wt.	1795 Vel.	1795 Wt.	2735 Vel.	2735 Wt.	6039 Vel.	6039 Wt.	6087 Vel.	6087 Wt.
4586·191									− 5·1	1				
4584·018											−28·3	1	−28·8	1
4581·618	+11·0	1	+ 4·6	1	−27·6	1			5·2	1½	27·0	1	26·1	1
4580·407							−14·7	1	14·5	1			33·8	1
4565·726	10·9	1½	8·4	1	33·0	1	14·3	1	13·0	1½	29·0	1	31·7	1
4556·202									15·9	¾				
4554·257	9·7	1	6·7	1	33·4	1	10·9	1	10·0	1	25·4	1	25·5	1
4552·594	11·9	1							12·4	1	28·5	1	30·1	1
4549·766	14·3	1½	3·0	1½	32·5	1½	14·4	1½	10·0	1	29·2	1	26·4	1
4535·965	8·2	1½	5·0	1	26·5	1½	17·7	1½	8·9	1	26·7	1	25·2	1
4534·169			8·8	1										
4531·202	7·5	1	3·7	½					15·5	¾	34·8	1	29·2	1
4528·807	9·2	1	3·2	1	25·6	½	14·5	1	10·7	1	28·3	1	26·9	1
4522·855	7·7	1	2·6	½	26·6	½	14·2	½	5·6	¾			23·3	1
4520·397											32·7	1		
4515·508											33·1	1		
4494·664									15·4	¾	26·0	1		
4482·376	6·2	1							8·6	1				
4476·214			3·0	1	29·9	1	9·7	1			33·5	1	27·9	1
4469·545	12·6	1	7·3	1			9·4	1			23·0	1	25·2	1
4468·663									8·2	1				
4466·727	13·3	1	8·8	1	19·5	1					−24·2	1	21·4	1
4454·962			7·6	1			−15·6	½	− 8·3	1				
4415·354	6·0	1												
4395·286													−26·0	1
4352·908	+14·8	1	+ 7·0	1	−19·3	1								
Weighted mean	+ 10·31		+ 5·80		− 27·73		− 13·64		− 10·12		− 28·65		− 27·17	
V_a	− 18·86		− 13·74		+ 18·93		− 0·35		+ 2·69		+ 16·69		+ 18·67	
V_d	− ·28		− ·27		+ ·10		− ·19		+ ·10		+ ·22		+ ·10	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 9·1		− 8·5		− 9·0		− 14·5		− 7·6		− 12·0		− 8·7	

MEASURES OF ε CYGNI—*Continued*

λ	6107		6149		6170		6181		6194		6208		6213	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4586·191	−22·9	1							−24·4	1	−16·7	1	−12·5	1
4584·018	27·6	1	−20·0	1										
4581·618	23·7	1	13·8	1	−16·6	1	−23·9	¾	16·5	½	19·0	1	15·3	1
4580·407	31·8	1			16·9	1	29·7	¾	27·4	1	21·8	1	20·1	1
4565·726	28·6	1	16·2	1	19·8	1	25·7	¾	25·7	1	19·2	1	22·6	1
4563·939									31·3	½				
4556·202									22·7	½	20·3	1		
4554·257	26·6	1	14·2	1	20·2	1	18·0	½	23·0	1	16·4	1	17·8	1
4552·594	32·4	1	12·6	1	22·2	1	26·4	¾	24·0	½	17·9	1	13·9	1
4549·766	30·1	1	19·7	1	19·2	1	27·9	¾	21·7	1	18·6	1	15·5	1
4535·965	28·5	1	17·5	1	20·3	1	23·8	1	22·5	1	13·6	1	17·2	1
4534·169			19·5	1										
4531·202			22·3	1	23·8	1					23·0	1	22·7	1
4528·807	28·5	1	19·6	1	18·3	1			24·4	½	19·6	1	20·2	1
4522·855	30·0	1	18·2	1	17·0	1	21·7	½	29·3	½	18·3	1	14·9	1
4520·397					19·9	1								
4515·508	27·3	1			19·4	1								
4494·664			18·6	1	22·4	1			18·8	½	19·6	1	19·5	1
4476·214					23·1	1			25·7	½	21·1	1	19·3	1
4472·957	21·3	1	18·3	1			24·2	1	19·9	1	17·8	1	18·2	1
4469·545							21·1	½						
4466·727	24·6	1	15·0	1	−15·4	1					16·5	1	14·5	1
4464·772			13·9	1					17·5	½			15·5	1
4459·304													−19·7	1
4454·962									−25·8	½	−16·8	1		
4415·354	29·4	1					−26·6	¼						
4395·286	−35·2	1	−19·6	1										
Weighted mean	− 28·03		− 17·44		− 19·63		− 23·81		− 23·53		− 18·60		− 17·61	
V_a	+ 17·19		+ 13·04		+ 12·05		+ 10·79		+ 10·21		+ 9·40		+ 8·89	
V_d	·00		+ ·14		− ·06		+ ·22		− ·13		− ·08		+ ·22	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 11·1		− 4·5		− 7·9		− 13·1		− 13·7		− 9·6		− 8·8	

MEASURES OF ε CYGNI—*Continued*

λ	6225		6229		6237		6240		6259		6259*		6278	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4586·191	− 7·5	¾	−14·1	1	−13·4	1	−14·4	1	− 7·0	1	− 6·6	1	− 9·1	1½
4584·018	16·3	¾	13·5	¾	......		......		8·2	1	5·4	1	......	
4581·618	16·2	1	12·8	1	14·7	1½	14·2	1	8·4	1	7·5	1	9·6	1½
4580·407	11·5	1	......		......		17·9	1	18·5	½	15·3	½	......	
4565·726	17·5	1½	16·9	1	17·5	1½	17·2	1	14·8	1½	15·1	1½	12·0	1
4563·939	......		......		17·5	1	......		......		......		......	
4556·202	......		......		......		19·2	1	22·9	1	21·6	1	9·9	¾
4554·257	10·7	1	11·8	1	21·7	¾	17·2	1	10·2	½	7·8	½	12·5	1
4552·594	15·3	1	16·3	¾	17·4	1	15·6	1	17·1	¾	16·7	¾	13·7	¾
4549·766	10·6	1½	10·6	1	17·6	1	19·3	1	12·6	1	11·4	1	8·0	¾
4535·965	13·5	1	14·9	¾	13·6	1	17·3	1	8·2	1	6·6	1	9·8	¾
4531·202	......		......		22·0	¾	21·1	½	......		......		5·2	½
4528·807	13·3	1	14·2	1	15·5	1	18·4	1	12·5	1	13·7	1	4·9	1
4525·285	15·0	1	......		......		......		......		......		......	
4522·855	13·7	¾	14·5	¾	14·6	1	14·8	1	9·0	1	9·4	1	8·0	1
4515·508	13·8	1	......		17·2	1	18·3	1	15·8	1	17·3	1	12·8	½
4501·448	......		......		19·5	1	......		......		......		......	
4494·664	......		......		12·3	1	20·2	1	......		......		14·6	¾
4476·214	18·1	¾	16·2	1	11·8	1	......		4·7	1	5·8	1	10·9	1
4472·957	7·0	1	−16·5	¾	17·9	1	15·6	1	11·6	1	12·6	1	− 5·8	¾
4469·545	14·4	1	......		9·5	1	14·9	½	9·2	1	12·0	1	......	
4468·663	......		......		19·1	1	......		......		......		......	
4466·727	......		......		−12·3	1	......		......		......		......	
4464·772	......		......		......		13·0	¾	6·4	1	6·8	1	......	
4459·304	−12·5	1	......		......		......		......		......		......	
4454·962	......		......		......		−19·7	1	11·0	1	12·3	1	......	
4415·354	......		......		......		......		14·1	1	13·1	1	......	
4395·286	......		......		......		......		15·2	¾	17·7	¾	......	
4371·312	......		......		......		......		12·3	¾	11·8	¾	......	
4369·856	......		......		......		......		13·4	¾	14·4	¾	......	
4352·908	......		......		......		......		13·9	1	13·4	1	......	
4352·006	......		......		......		......		−10·4	1	−11·9	1	......	
Weighted mean	− 13·36		− 14·25		− 15·92		− 17·12		− 11·82		− 11·88		− 9·76	
V_a	+ 7·70		+ 6·77		+ 6·15		+ 5·60		+ 4·64		+ 4·64		+ 1·15	
V_d	+ ·03		− ·16		·00		+ ·05		− ·11		− ·11		− ·02	
Curv.	− ·28		− ·28		− ·28		− ·66		− ·28		− ·28		− ·28	
Radial Velocity	− 5·9		− 7·9		− 10·0		− 12·1		− 7·6		− 7·6		− 8·9	

*Check measurement

MEASURES OF ε CYGNI—*Continued*

λ	6282		6297		6298		6320		6325		6334		6347	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4586·191	− 2·0	¾	− 4·6	1	− 3·3	1	− 1·0	1	+ 1·5	1	+ 5·3	¾	+ 3·0	1
4584·018	9·8	1	...	...	8·8	1	...	...	...	...	...	...	− 4·4	1
4581·618	7·3	1	9·4	1	4·7	1	2·7	1	− 2·8	1½	− 2·9	1	− 2·6	1
4580·407	3·1	¾	6·9	1	8·3	1	7·0	1	− 3·8	1	− 5·1	¾	− 0·9	1
4565·726	6·6	1	14·0	1	8·0	1	6·3	1	− 5·2	1½	− 3·9	1	− 8·3	1
4556·202	...	...	15·2	½	11·3	1	...	...	...	...	+ 4·6	1	...	...
4554·257	8·5	1	13·0	¾	8·4	1	2·9	¾	− 5·6	1	...	...	− 6·1	1
4552·594	5·4	1	17·5	½	7·1	1	6·6	1	− 7·2	1	− 2·6	1	− 6·1	1
4549·766	6·4	1	11·3	1	3·2	1	4·4	1	− 4·2	1½	− 3·3	1	− 6·1	1
4535·965	4·6	1	7·8	1	6·4	1	5·4	1	− 4·4	1	− 1·0	¾	− 6·8	1
4531·202	...	...	...	...	...	...	4·0	1	−10·8	¾	...	...	...	...
4528·807	5·0	1	11·4	1½	10·0	1	5·4	1¼	− 2·3	1	− 4·2	1	− 3·0	1
4522·855	3·0	1	5·6	1	8·8	1	2·9	¾	− 4·9	¾	− 6·1	1	− 5·5	1
4515·508	11·6	1	12·1	¾	5·6	1	...	...	− 2·4	½	...	...	...	...
4494·664	2·4	½	17·4	1	8·4	1	9·5	¾	− 4·2	1	− 8·7	¾	− 7·3	1
4482·376	...	...	...	...	...	...	...	...	...	...	+ 2·3	¾	...	...
4476·214	10·1	1	...	...	10·4	1	14·8	¾	− 4·1	1	− 5·3	1	− 6·1	1
4472·957	− 2·8	1	12·6	½	6·6	1	8·0	¾	− 5·8	1	− 1·2	1	− 4·2	1
4469·545	...	...	8·3	½	9·2	1	0·9	¾	+ 0·5	1	...	...	− 2·4	1
4466·727	...	...	6·6	½	− 1·9	1	3·4	¾	− 4·3	1	+ 0·6	1	0·0	1
4464·772	...	...	− 5·8	½	...	...	...	...	...	...	+ 3·6	1	...	...
4459·304	...	...	...	...	...	...	...	...	...	...	− 0·3	1	...	...
4454·962	...	...	...	...	...	...	7·7	¾	...	...	...	...	...	...
4427·420	...	...	...	...	...	...	...	...	− 6·5	½	...	...	...	...
4415·354	...	...	...	...	...	...	−12·5	¾	− 5·8	1	...	...	...	...
Weighted mean	− 6·18		− 10·88		− 7·25		− 5·67		− 4·29		− 1·68		− 4·18	
V_a	+ 0·13		− 1·14		− 1·73		− 2·77		− 4·00		− 5·26		− 6·83	
V_d	− ·22		− ·11		+ ·16		− ·16		+ ·12		+ ·12		+ ·11	
Curv.	− ·28		+ ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 6·6		− 12·4		− 9·1		− 8·9		− 8·4		− 7·1		− 11·2	

MEASURES OF ε CYGNI—*Continued*

λ	6393		6534		7056		7056*		7065		7070		7086	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Vel.	Vel.	Wt.
4586·191			+12·6	¾	−25·8	1	−23·0	1	−23·2	1	−16·7	1	−16·6	¾
4584·018			7·3	1	33·9	½	33·0	1	30·4	1				
4581·618			10·1	¾	29·7	1	28·6	1	28·6	1	21·9	1	23·8	¾
4580·407	+ 2·6	1	7·4	½					29·7	1	25·6	1	26·8	½
4572·156					34·0	1			30·2	1				
4565·726	+ 8·4	1	9·3	¾	31·6	1	30·8	1						
4554·257			9·0	½	30·6	½	29·0	1	32·6	1	24·5	1	18·9	1
4552·594	+ 3·6	¾	9·0	½	28·6	1	26·3	1	30·4	1			28·3	½
4549·766	+ 0·3	1	5·7	1	28·5	1	27·3	1	28·0	1	25·5	1	22·7	1
4535·965	+ 3·7	1	9·1	1	25·6	1	24·9	1	27·8	1	24·7	1	15·1	½
4534·169					24·5	1								
4531·202			2·4	1					30·9	1	27·3	1		
4528·807	− 1·2	1	6·4	1	28·9	1	26·2	1	30·6	1	29·7	1	27·2	1
4525·285									33·7	1	34·9	1		
4522·855			10·5	¾	30·7	1	30·7	1	30·0	1	28·0	1	19·7	1
4515·508			5·1	¾										
4494·664	− 8·1	¾	6·2	1			24·6	½	28·3	1	30·7	1	21·8	½
4482·376									26·4	1				
4476·214	− 1·1	1	1·3	1	22·6	½			28·7	1	27·6	1½	21·8	1
4472·957			5·9	1	26·8	1	22·8	1	24·6	1	21·3	1		
4469·545					26·0	1			24·9	1				
4468·663					29·4	1								
4466·727			10·0	¾	31·1	½	26·6	½					−20·3	1
4464·772	+ 8·2	1	10·4	¾										
4459·304			+ 7·4	¾	31·5	1	28·5	1						
4454·962											26·3	1		
4427·420							25·3	1			26·4	1		
4415·354	− 0·9	1			−28·6	1	−29·8	1	−32·3	1	−25·6	1		
4404·927	− 1·9	¾												
4395·286	− 0·8	1												
4352·908	+ 9·2	¾												
4352·006	− 0·2	1												
Weighted mean	+ 1·62		+ 7·40		− 28·81		− 27·45		− 29·02		− 26·04		− 21·69	
V_o	− 9·28		− 17·62		+ 17·86		+ 17·86		+ 16·57		+ 16·14		+ 13·97	
V_d	− ·16		− ·09		+ ·04		+ ·04		+ ·03		+ ·07		− ·07	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 8·1		− 10·6		− 11·2		− 9·8		− 12·7		− 10·1		− 8·1	

*Check measurement

MEASURES OF ε CYGNI—*Continued*

λ	7094		7095		7097		7100		7106		7107		7114	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4586·191	−19·0	1	−17·9	½	−19·4	1	−17·6	1	−15·2	1	−12·5	1	−17·1	1
4584·018	....	....	22·7	½	25·8	1	....	....	....	....	23·9	1	23·0	1
4581·618	27·4	1	15·4	½	21·0	1	22·3	1	20·9	1	18·5	1	20·0	1
4580·407	....	....	18·9	½	26·2	1	21·3	1	30·6	½	....	....	26·6	1
4565·726	....	....	....	....	....	....	....	....	21·8	1	22·0	1	22·4	1
4556·202	....	....	....	....	25·8	1	....	....	....	....	....	....	21·5	1
4554·257	....	....	22·0	½	17·4	1	23·8	1	27·1	1	17·1	1	19·2	1
4552·594	25·5	1	20·2	½	21·1	1	21·8	1	21·3	1	20·9	1	17·1	1
4549·766	22·4	1	11·2	½	21·3	1	18·5	1	22·4	1	16·8	1	20·0	1
4535·965	23·2	1	23·4	½	17·7	1	18·7	1	20·5	1	19·6	1	19·0	1
4531·202	....	....	....	....	23·8	1	....	....	....	....	....	....	....	....
4528·807	23·4	1½	−23·4	½	22·8	1	22·8	1	22·3	1	18·6	1	21·4	1
4522·855	22·8	1	....	....	23·9	1	19·6	1	20·8	1	24·7	1	17·7	1
4494·664	21·4	1	....	....	20·2	1	21·4	1	....	....	21·1	1	17·5	1
4476·214	21·5	1	....	....	18·7	1	26·3	1	20·5	1	21·0	1	....	....
4472·957	20·4	1	....	....	19·1	1	19·4	1	17·7	1	....	....	21·1	1
4469·545	....	....	....	....	23·3	1	20·4	1	....	....	....	....	17·7	1
4466·727	17·8	½	....	....	18·8	1	16·8	1	16·3	1	16·0	1	17·4	1
4464·772	....	....	....	....	....	....	....	....	15·9	1	17·4	1	18·8	1
4459·304	20·9	1	....	....	....	....	20·9	1	25·4	½	....	....	21·9	1
4427·420	24·2	1	....	....	....	....	22·0	1	28·0	1	21·1	1	22·6	1
4415·354	29·0	1	....	....	−30·7	1	−24·6	1	23·3	1	−22·5	1	−19·8	1
4395·286	27·6	1	....	....	....	....	....	....	....	....	....	....	....	....
4352·908	23·2	1	....	....	....	....	....	....	−21·6	1	....	....	....	....
4352·006	−27·1	1	....	....	....	....	....	....	....	....	....	....	....	....
Weighted mean	− 23·51		− 19·46		− 22·06		− 21·04		− 21·38		− 19·61		− 20·09	
V_a	+ 12·11		+ 11·88		+ 11·35		+ 11·09		+ 10·07		+ 9·52		+ 9·26	
V_d	− ·05		+ ·14		+ ·07		− ·06		+ ·12		+ ·23		− ·15	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 11·7		− 7·7		− 10·9		− 10·3		− 11·5		− 10·1		− 11·3	

MEASURES OF ε CYGNI—*Concluded*

λ	7117		7120		7121		7131		7136		7142			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4586·191	−21·0	1	−19·6	1	−15·2	1	−10·8	1	−10·1	1	−10·2	1	....	...
4584·018	....	...	....	...	21·0	1	21·8	1	14·2	1	....	...	....	...
4581·618	24·5	1	17·4	1	16·9	1	14·1	1	11·9	1	16·2	1	....	...
4580·407	23·9	1	26·1	¾	21·6	1	21·9	1	20·7	1	18·3	1	....	...
4565·726	23·0	1	24·6	¾	20·6	1	18·7	1	16·8	1	18·2	1	....	...
4556·202	29·7	1	24·0	¾	....	...	12·7	1	15·2	1	....	...	....	...
4554·257	24·8	1	15·3	¾	16·0	1	19·4	1	13·3	1	....	...	....	...
4552·594	22·6	1	18·6	¾	17·8	1	18·2	1	15·8	1	14·0	1	....	...
4549·766	23·4	1	15·2	¾	19·2	1	16·3	1	13·9	1	14·7	1	....	...
4535·965	24·1	1	18·0	1	19·8	1	17·4	1	13·8	1	16·0	1	....	...
4531·202	28·8	1	....	...	....	...	....	...	....	...	....	...	....	...
4528·807	22·9	1	16·9	¾	20·1	1	16·9	1	16·3	1	18·5	1	....	...
4525·285	....	...	....	...	....	...	22·7	1	....	...	....	...	....	...
4522·855	22·9	1	−22·0	½	23·7	1	16·4	1	17·5	1	15·1	1	....	...
4494·664	18·8	1	....	...	16·8	1	19·1	1	14·6	1	21·1	1	....	...
4476·214	25·2	1	....	...	18·0	1	22·2	1	16·8	1	14·4	1	....	...
4472·957	19·3	1	....	...	17·5	1	15·2	1	13·3	1	11·8	1	....	...
4469·545	....	...	....	...	20·0	1	....	...	13·6	1	....	...	....	...
4468·663	....	...	....	...	17·3	1	....	...	....	...	....	...	....	...
4466·727	16·6	1	....	...	15·0	1	11·2	1	5·9	1	6·7	1	....	...
4459·304	17·4	1	....	...	17·8	1	....	...	....	...	12·3	1	....	...
4427·420	26·2	1	....	...	21·8	1	14·7	1	14·6	1	18·7	1	....	...
4415·354	−20·7	1	....	...	19·0	1	−16·8	1	....	...	−17·6	1	....	...
4352·908	....	...	....	...	20·1	1	....	...	−19·9	1	....	...	....	...
4352·908	....	...	....	...	−23·6	1	....	...	....	...	....	...	....	...
Weighted mean	− 22·94		− 19·67		− 19·04		− 17·18		− 15·17		− 15·24		....	
V_a	+ 8·73		+ 8·31		+ 7·52		+ 6·73		+ 5·67		+ 3·49		....	
V_d	− ·16		− ·19		+ ·23		− ·13		+ ·07		+ ·06		....	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		....	
Radial Velocity	− 14·6		− 11·8		− 11·6		− 10·9		− 9·7		− 12·0		....	

Dominion Observatory
Ottawa
April, 1919.

PUBLICATIONS

OF THE

DOMINION OBSERVATORY

OTTAWA, CANADA

Vol. IV, No. 22

RADIAL VELOCITIES OF 30 STARS

BY W. E. HARPER, M.A.

During the course of several years' work at this observatory a considerable number of miscellaneous measures of radial velocity have accumulated. Some of these are of spectroscopic binaries already announced, while others are of stars for which no previous measures were known. In the case of the latter, a few have been found to be variable in velocity and are so indicated in the column of remarks of the following table or in the text. Some of the binaries could with profit be continued, while others are either too uncertain for measurement or have such a small range that greater dispersion is necessary to successfully tackle them. The stars with their approximate positions for 1900, the number of plates secured, and other data are given in the following table.

Star	α		δ		Plates	Remarks
	h	m	°	′		
η Piscium	1	26	+14	50	40	uncertain binary
o Ceti	2	14	− 3	26	4	
35 Arietis	2	38	+27	17	5	constant velocity
Boss 678	2	54	+51	57	5	suspected binary
Boss 744	3	12	+49	43	4	
Boss 783	3	22	+49	30	2	
Boss 839	3	36	+33	39	7	new spec. binary
42 Persei	3	43	+32	48	4	
Boss 898	3	49	+47	35	2	
Boss 947	4	01	+47	27	5	new spec. binary
ψ Orionis	5	22	+ 3	01	16	
ι Orionis	5	30	− 5	59	30	
30 Canis Majoris	7	15	−24	47	3	
Boss 2381	8	47	− 6	49	2	
36 Lyncis	9	07	+43	38	5	
ζ Leonis	10	11	+23	55	3	

Star	α		δ		Plates	Remarks
	h	m	°	′		
π 8 Virginis	11	56	+ 7	10	15	
16 Comæ	12	22	+27	22	4	
12 Canum Venaticorum	12	51	+38	52	4	new spec. binary
τ Virginis	13	57	+ 2	02	12	constant velocity, − 2
33 Boötis	14	35	+44	50	2	
10 Serpentis	15	24	+ 2	12	4	
12 Coronæ Borealis	15	52	+38	14	3	
21 Ophiuchi	16	46	+ 1	23	4	
101 Herculis	18	05	+20	01	4	
Boss 4669	18	22	+29	46	2	
50 Draconis	18	50	+75	20	28	additional measures
Boss 5070	19	47	+40	20	7	
13 Vulpeculæ	19	49	+23	50	6	
Boss 5535	21	28	+60	01	4	

η PISCIUM

(1900, $\alpha = 1^h\ 26^m \cdot 1$, $\delta = +\ 14°\ 50'$, mag. 3·72, type G5)

In the *Astrophysical Journal*, volume XIX, page 249 and volume XXI, page 313, are given the measures of 15 plates taken by Lord at the Emerson McMillan Observatory in the years 1901 to 1905. The range shown is from +9·5 to +24·9, and Lord suspected that the star was a spectroscopic binary of long period. Giving his plates equal weight would bring the mean velocity about +16·4 km. per second.

From 1897 to 1904 there were 7 plates of the star secured at the Lick Observatory with practically no range in velocity shown. Campbell used the mean +15·5 km. per sec. as the velocity of the star, though he stated that Lord's contention of its spectroscopic character was neither proved nor disproved by his plates.

From 1904 to 1907 Küstner secured 4 plates with a single-prism spectrograph showing no appreciable range and giving a mean velocity of +14·8 km. per second.

In 1906, 1907 and 1908 there were 44 plates secured here as given in the table following. For reasons given in the column of remarks the numbers 606, 624, 1057 and 1254 have not been considered in the discussion. Of the remaining 40 plates, 16 were made with the three-prism universal spectroscope adapted for radial velocity work, 5 with the single-prism long-focus camera, and the remaining 19 with the regular three-prism long-focus camera arrangement. From our early plates it was felt that the variation was real and the period short, and a number of plates were made and measured—the labourious method of applying the Hartman-Cornu formula for each line being used—before it was suspected that some systematic error in the instrument might be the cause of the variations measured. This suspicion is probably the correct view for the universal and single-prism instruments, as in the early stages of the work they were not so perfect as later experience made them.

The range shown by the plates of the regular three-prism instrument is 11 km. but if three of these are omitted, in which only about half the usual number of lines are measured, the greatest range is about 3 km. It would appear only reasonable, then, to assume that if the star is a spectroscopic binary its range of variation is very small. On the assumption that its velocity is constant, the mean of either the universal plates or the single-prism plates is +12·3 km. per sec., while for the three-prism it is +14·1 km. per sec. Weighting the single, universal and three-prism arrangements as 1, 2 and 3 the mean velocity is +13·3 km. per second.

MEASURES OF η PISCIUM

Plate	Inst.	Date	Vel.	n	Remarks
		1906			
403	U	Sept. 27·847	+10·7	7	
		1907			
554	"	Jan. 18·543	+ 3·6	26	
562	"	" 21·550	+16·3	25	
568	"	" 22·604	+10·7	28	
584	"	" 28·526	+10·0	28	
588	"	" 30·552	+ 5·1	23	
595	"	Feb. 4·542	+16·3	17	
598	"	" 6·521	+ 6·5	29	
606	"	" 7·529	+26·4	10	plate underexposed
608	"	" 8·542	+17·9	14	
616	"	" 21·487	+ 5·2	18	
617	"	" 21·529	+18·1	23	
624	"	" 22·500	+ 3·8	20	temperature change
625	"	" 25·539	+21·4	24	
634	"	" 25·543	+18·6	24	
635	"	" 25·580	+18·5	8	
641	"	" 27·507	+10·9	25	
642	"	" 27·544	+16·0	15	
955	I L	July 18·799	+ 0·6	7	
1003	III L	Aug. 10·494	+18·4	9	
1036	I L	Sept. 6·750	+ 8·0	17	
1041	"	" 12·767	+12·9	17	
1051	"	" 18·660	+19·1	18	
1054	"	" 18·781	+13·2	19	
1057	"	" 18·885	+ 8·5	10	plate underexposed
1095	III L	Oct. 8·734	+12·2	26	
1096	"	" 8·799	+12·2	25	
1102	"	" 18·670	+13·0	16	
1103	"	" 22·647	+15·1	14	
1104	"	" 23·644	+11·8	25	
1105	"	" 23·697	+13·9	18	
1107	"	" 25·633	+13·2	19	
1164	"	Nov. 29·543	+14·3	17	
1165	"	" 29·589	+12·3	11	
1173	"	Dec. 4·577	+11·4	18	
1187	"	" 21·483	+14·1	18	

MEASURES OF η PISCIUM—*Concluded*

Plate	Inst.	Date	Vel.	n	Remarks
		1908			
1205	III L	Jan. 1·544	+13·9	16	
1211	"	" 3·501	+10·9	10	
1254	"	" 22·516	+ 8·5	9	underexposed
1796	"	Aug. 19·840	+14·3	13	
1869	"	Sept. 7·716	+12·8	21	
1982	"	Nov. 21·688	+13·9	12	
2002	"	Dec. 5·473	+22·4	8	
2069	"	" 23·538	+20·9	10	

o CETI

(1900, $\alpha = 2^h\ 14^m{\cdot}3$, $\delta = -3°\ 26'$, mag. var., type Md)

Four spectra of this well known variable star have been made since the extended series at the December 1906 maximum. Apart from the emission band at H_β, which was present at the 1906 maximum and is not seen at the time of these observations, the other emission and absorption bands seem to be similar to those of the earlier date. The measures of the sharp H_γ and H_δ emission are fairly reliable, those for the absorption lines only approximate. H_β emission seems to appear only at the brighter maxima.

Plate	Date, G.M.T.	Absorption		Emission	
		Vel.	Lines	Vel.	Lines
6786	1915, Feb. 17·525	+50	3	+48·7	2
6834	Mar. 4·500	+58	4	+45·1	1
8655	1918, Sept. 24·703	....	....	+49·2	2
8659	" 30·708	+70	3	+45·3	2

MEASURES OF *o* CETI

λ	6786		6834		8655		8659							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4535·965	+67·5	½	+83·2	½										
4404·927			87·8	½			+57·8	½						
4395·286							54·1	¼						
4325·939	88·5	½	73·0	¼			67·9	¼						
4308·081	69·1	¼	61·0	¼										
4340·634 em	78·2	1	70·9	1	+36·4	1	37·5	1						
4101·890 em	+71·6	1	+63·2	1	+35·3	1	+31·5	1						
Weighted mean	+ 76·24		+ 79·67				+ 59·40							
V_a	− 25·74		− 21·39		+ 13·45		+ 10·81							
V_d	− ·22		− ·25		+ ·17		+ ·14							
Curv.	− ·28		− ·28		− ·28		− ·28							
Radial Velocity	+ 50·0		+ 57·8				+ 70·1							
Emission	+ 48·7		+ 45·1		+ 49·2		+ 45·3							

35 ARIETIS

(1900, $\alpha = 2^h\ 37^m\cdot 6$, $\delta = +27^\circ\ 17'$, mag. 4·58, type B8)

No measures seem to have been published for this star. The lines of hydrogen and helium while fairly broad should give reasonable accuracy in the measures. Plate 3667 is underexposed, so that a variation in velocity cannot be said to be established.

Plate	Date, G.M.T.	Velocity	Lines
2708	1909, Aug. 2·837	+17	8
2858	Oct. 6·787	+23	7
3650	1910, Sept. 14·839	+14	8
3667	" 16·758	+35	3
8717	1919, Feb. 24·526	+19	7

MEASURES OF 35 ARIETIS

λ	2708		2858		3650		3667		8717					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	......	...	+ 0·3	¼	+ 1·0	¼	......	...	+83·6	¼	......	...	......	...
4481·400	− 9·3	¼	......	...	......	...	......	...	43·9	¼	......	...	......	...
4471·676	−17·6	¼	+ 5·4	¼	− 4·5	½	− 7·1	¼	38·1	½	......	...	......	...
4388·100	+ 6·7	¼	......	...	+ 6·7	¼	......	...	44·7	¼	......	...	......	...
4340·634	−21·2	½	+33·2	½	−20·0	½	+13·8	¼	48·7	½	......	...	......	...
4143·928	+ 7·2	¼	+21·0	¼	+20·0	¼	......	...	......	...	......	...	......	...
4101·890	− 6·7	¼	−24·9	¼	−13·7	¼	+30·1	¼	58·9	¼	......	...	......	...
4026·352	−19·3	½	0·0	½	−21·6	½	......	...	+20·0	¼	......	...	......	...
3933·825	−17·6	¼	+ 8·4	½	−17·2	½	......	...	......	...	......	...	......	...
Weighted mean	− 11·80		+ 8·52		− 9·37		+ 12·27		+ 47·16		......		......	
V_a	+ 28·66		+ 15·20		+ 23·24		+ 22·66		− 27·91		......		......	
V_d	+ ·18		− ·02		·00		+ ·11		− ·20		......		......	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		......		......	
Radial Velocity	+ 17·0		+ 23·4		+ 13·6		+ 34·8		+ 18·8		......		......	

BOSS 678

(1900, $\alpha = 2^h\ 53^m \cdot 7$, $\delta = +51^\circ\ 57'$, mag. 5·42, type B5)

The star's spectrum consists of broad lines of hydrogen and traces of the magnesium λ 4481. The probable error of measurement is high, and the values given below may be as much as 10 km. in error. The H_γ line, however, is fairly uniform throughout its breadth and is thus fairly reliable, and judging by it alone there would seem to be good reason for considering the velocity of the star to be variable.

Plate	Date, G.M.T.	Number of lines	Velocity
8335	1917, Nov. 5·685	2	+11
8347	" 12·568	2	−44
8668	1918, Oct. 21·649	4	+ 3
8688	Dec. 9·638	3	± 0
8706	1919, Jan. 27·552	3	+ 4

MEASURES OF BOSS 678

λ	8335		8347		8668		8688		8706					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	....	....	....	....	−37·8	1/4	−20·9	1/8	+30·2	1/4	....	....	....	....
4340·634	+ 9·8	1/4	−43·0	1/4	+ 6·0	3/4	+13·5	1/2	+22·1	3/4	....	....	....	....
4101·890	+ 4·6	1/2	−53·3	1/8	− 9·0	1/2	+19·7	1/8	+36·3	1/2	....	....	....	....
3970·177	....	....	....	....	−17·6	1/2	....	....	....	....	....	....	....	....
Weighted mean	+ 6·33		− 46·43		− 9·10		+ 8·80		+ 28·19		....		....	
V_a	+ 5·08		+ 3·00		+ 12·03		− 8·58		− 23·48		....		....	
V_d	+ ·03		+ ·14		+ ·11		− ·03		− ·09		....		....	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		....		....	
Radial Velocity	+ 11·2		− 43·6		+ 2·8		− 0·1		+ 4·3		....		....	

BOSS 744

(1900, $\alpha = 3^h\ 12^m\cdot 0$, $\delta = +49°\ 43'$, mag. 5·08, type B3)

The hydrogen lines in the spectrum of this star are about 10 angstroms wide and thus there is considerable uncertainty in the measures. The lines λ 4471 and λ 4026 are the only ones seen of the helium series and they are very faint. It is not likely that the range shown in the measures represents a real variation in velocity.

Plate	Date, G.M.T.	Number of lines	Velocity
8331	1917, Nov. 4·787	4	− 6
8339	" 7·779	6	−32
8678	1918, Nov. 5·659	4	− 1
8689	Dec. 9·694	3	−16

MEASURES OF BOSS 744

λ	8331		8339		8678		8689							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	− 2·4	¼	−46·5	¼	+22·3	¼	−39·3	¼						
4471·676	−46·0	⅛	−56·6	¼	−18·7	¼								
4340·634	+ 1·1	¼	−25·3	½	−23·8	½	− 5·5	½						
4101·890	−21·5	¼	−14·7	⅛	+ 3·8	¼	+43·8	⅛						
4026·352			−32·7	⅛										
3970·177			−64·8	⅛										
Weighted mean	− 13·09		− 38·11		− 8·00		− 8·12							
V_a	+ 7·55		+ 6·25		+ 7·28		− 7·88							
V_d	− ·09		− ·09		+ ·09		− ·09							
Curv.	− ·28		− ·28		− ·28		− ·28							
Radial Velocity	− 5·9		− 32·2		− 0·9		− 16·4							

BOSS 783

(1900, $\alpha = 3^h\ 21^m \cdot 7$, $\delta = +49° \ 30'$, mag. 5·64, type B5)

The hydrogen lines are from 10 to 15 angstroms broad and consequently the velocities obtained are only approximate. If the star is not a binary, the velocities should be about zero as it is one of the stars in the Taurus cluster. No results have hitherto been published.

Plate	Date, G.M.T.	Velocity	Lines
8357	1917, Nov. 14·661	+25	1
8694	1918, Dec. 26·564	+29	3

BOSS 839 or 40 PERSEI

(1900, $\alpha = 3^h\ 36^m \cdot 0$, $\delta = +33° \ 39'$, mag 5·04, type B2)

The measures on the 7 plates secured here are sufficiently reliable to show that this star has a variable radial velocity. A line of unknown origin, whose wave-length has been assumed as 4070·118, is quite sharp on some of the plates.

Plate	Date, G.M.T.	Velocity	Lines
8338	1917, Nov. 7·663	+23·2	9
8428	1918, Jan. 23·490	+23·7	6
8693	Dec. 18·719	+ 3·6	7
8696	" 26·668	− 8·8	6
8698	1919, Jan. 6·506	+33·7	4
8705	" 27·484	− 8·8	7
8711	Feb. 10·631	− 1·7	6

MEASURES OF BOSS 839

λ	8338		8428		8693		8696		8698		8705		8711	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	−7·2	¼	...	...	+27·8	¼	+22·3	¼	...	...	+17·8	¼	+20·2	¼
4471·676	+19·6	½	+48·3	½	+12·4	½	+13·0	½	+63·4	½	+33·8	¼	24·8	½
4388·100	+42·1	½	63·1	½	+9·6	¼	+1·4	½	77·1	½	+27·1	¼	13·1	¼
4340·634	+17·9	½	66·9	¼	+16·4	½	+13·1	½	33·0	½	+17·6	½	41·4	½
4143·928	+2·2	¾	47·1	¼	+27·4	½	−7·1	¼	...	...	...	...	24·7	¼
4101·890	+38·6	½	...	...	+23·4	¼	...	...	+37·2	¼	+10·7	¼	+30·8	¼
4070·118	+23·1	1	37·0	¾	...	...	+6·8	½	...	...	−1·3	¼	...	...
4026·352	−3·4	¼	+52·8	¼	−0·8	¼	...	...	...	...	+23·6	¼	...	...
3933·825	−2·9	½	...	...	...	...	...	...	...	...	...	...	...	...
Weighted mean	+16·57		+50·04		+17·24		+8·36		+54·89		+18·40		+27·65	
V_a	+7·05		−26·11		−13·23		−16·74		−20·99		−26·92		−28·89	
V_d	−·11		+·05		−·14		−·12		+·10		+·03		−·20	
Curv.	−·28		−·28		−·28		−·28		−·28		−·28		−·28	
Radial Velocity	+23·2		+23·7		+3·6		−8·8		+33·7		−8·8		−1·7	

42 PERSEI

(1900, $\alpha = 3^h\ 43^m \cdot 2$, $\delta = +32°\ 48'$, mag. 5·10, type A)

This star was announced a binary by Adams in *Astrophysical Journal*, XXXV, 174, from 4 plates in 1911. Our measures indicate that the period is short.

Plate	Date, G.M.T.	Velocity	Lines
6311	1914, Aug. 25·870	−44	7
6459	Oct. 1·802	−28	6
6468	" 2·744	+19	6
6582	Nov. 27·697	−50	4

MEASURES OF 42 PERSEI

λ	6311		6459		6468		6582							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	−59·8	¼	−49·6	¼	− 9·5	¾								
4534	68·0	¼												
4501			46·0	¼										
4481	63·4	½	54·4	½	− 5·6	½	−40·3	½						
4340	73·1	½	43·3	¾	− 0·8	½	47·5	1						
4233			47·2	½										
4202							50·0	1						
4143					−23·6	¼								
4101	68·3	¼												
4063					+16·2	½								
4045	76·4	½												
3933	−89·0	½	−66·6	½	− 2·9	¼	−48·7	¾						
Weighted mean	− 72·73		− 51·11		− 3·24		− 47·42							
V_a	+ 28·71		+ 22·86		+ 22·57		− 2·29							
V_d	+ ·11		+ ·07		+ ·14		− ·02							
Curv.	− ·28		− ·28		− ·28		− ·28							
Radial Velocity	− 44·2		− 28·5		+ 19·2		− 50·0							

BOSS 898

(1900, $\alpha = 3^h\ 48^m \cdot 7$, $\delta = +47° \ 35'$, mag. 5·34, type B5)

The helium λ 4471 and H_γ are the only measurable lines on our plates, both being very broad and ill-defined. The star belongs to the Taurus moving cluster and should have a velocity around zero.

Plate	Date	Velocity	Lines
8348	1917, Nov. 12·626	−16	2
8363	" 26·657	−14	2

BOSS 947 or 48 PERSEI

(1900, $\alpha = 4^h\ 01^m \cdot 4$, $\delta = +47° \ 27'$, mag. 4·03, type B3)

This spectrum was described by Frost in *Astrophysical Journal*, XVIII, 389, 1903, as having bright hydrogen lines on broader absorption bands. H_β and H_γ were doubly bright, while H_δ only faintly visible. Adams and Lasby in *Publications of the Astronomical Society of the Pacific*, 23, 240, record H_β and H_γ as being bright, presumably single as there is no mention of components. Merrill in *Lick Observatory Bulletin*, 237, describes 5 plates made in 1912, in which the emission showed sometimes as double and sometimes as single on the absorption bands. He gives a velocity, +7·1 km. per sec., for H_β emission on the plate of August 21st.

On the 5 plates secured here the emission never occurs in the double form. H_β is always present, while H_γ is absent on the third and fourth plates and very dim on the fifth plate. From measures made upon the emission lines, there seems no doubt of a real variation in velocity of the hydrogen envelope giving rise to them. Whether this can be explained through orbital motion or not cannot be stated, but the star is worthy of further investigation. The probable error for the absorption bands is so high that the velocities given, while approximate, are not to be considered as showing a variation. The absorption bands on plate 8716 are unusually faint.

Plate	Date, G.M.T.	Absorption		Emission	
		Velocity	Lines	Velocity	Lines
8336	1917, Nov. 5·723	+21	3	+ 5	2
8343	" 9·631	....	....	−11	2
8387	Dec. 22·510	− 8	4	+19	1
8716	1919, Feb. 17·607	+10	4	−30	1
8718	" 24·570	+ 2	3	−10	1

MEASURES OF BOSS 947

λ	8336		8343		8387		8716		8718					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4471·676					−30·8	¼	+44·3	¼						
4388·100	+ 2·5	¼												
4143·928					+34·8	¼	40·3	¼	+24·7	¼				
4101·890	14·1	¼			+26·8	⅛								
4026·352	+13·6	¼			− 7·8	¼	25·2	¼	21·9	¼				
3933·825							+36·6	1	34·6	¼				
4861·527 em	− 5·0	1	−16·7	½	+29·5	1	− 3·2	½	+17·0	¾				
4340·634 em	− 7·2	½	−26·7	¼										
Weighted mean	+ 10·20				+ 2·86		+ 36·60		+ 28·95					
V_a	+ 11·08		+ 9·40		− 10·36		− 26·55		− 26·92					
V_d	+ ·04		+ ·13		+ ·13		− ·18		− ·13					
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28					
Radial Velocity	+ 21·2				− 7·6		+ 9·6		+ 1·6					
Emission	+ 5·1		− 10·8		+ 19·0		− 30·2		− 10·3					

ψ ORIONIS

This star ($\alpha = 5^h\ 22^m$, $\delta = +\ 3°\ 01'$) was announced a binary by Frost and Adams in 1903, and its orbit published by Plaskett in *Astrophysical Journal*, XXVIII, 266, 1908. Some of the plates of this star and a number of those of ι Orionis were measured by the writer, who noted cases where the *K*-line of calcium was discrepant and where lines appeared to be double. For the purposes of the papers on "*H* and *K* lines of Calcium" and "Secondary Disturbances" given before the Ottawa Section of the R.A.S.C. sometime about 1910, the writer remeasured all the plates of these two stars where the *K*-line could be seen and where the lines were double. As these results were never published it has been thought well to give them here. In the table immediately following, the velocity of the system, + 12·0 km. per sec., has been subtracted from the measured velocities so as to get the relative orbital motion from which is deduced the ratios of the masses given in the fifth column. The second column simply gives Plaskett's velocities with 12 km. subtracted from each. From the last two columns the mean ratio of the masses is 0·63.

VELOCITIES OF COMPONENT STARS

Plate	Velocity Primary	Velocity Secondary	Lines	m_s/m
1158	−157·5	+222·9	4	·71
1183	+127·1	−186·7	6	·68
1208	+133·9	−242·3	4	·55
1209	+136·0	−229·0	1	·59
1238	−126·5	+224·4	5	·56
1271	+127·9	−240·7	2	·53
1304	+139·6	−226·8	1	·57
1312	+133·3	−202·5	4	·66
1317	+144·0	−198·3	4	·72
1319	+128·5	−180·8	5	·71
1336	+ 91·3	−168·7	3	·54
1347	−147·1	+245·5	4	·60
1395	−147·0	+279·8	3	·53

The *K*-line seems to vary, though the range is less than that for the other lines. A check plate, No. 4852 taken Feb. 23·502, 1912, agrees in the case of the main lines with the curve within the limits of the probable error, and its value for *K* is added in the table following. To clear the fractions, the weights assigned at the time of measurement are multiplied by 4 in the table following, in which the velocities quoted are simply those as measured relative to the sun. The error of measurement is large, but it should be within 15 or 20 km.

K-LINE VELOCITY

Plate	Velocity	Weight	Plate	Velocity	Weight
1138	+82	2	1239	− 9	2
1183	+14	1	1296	− 8	2
1209	−25	2	1312	+ 4	2
1214	+55	1	1317	+53	2
1215	+55	2	1333	+33	4
1220	+23	2	1347	−94	2
1221	+81	2	1349	−65	1
1233	+16	1	4852	+12	4

ι ORIONIS

The orbit of this star ($\alpha = 5^h 30^m$, $\delta = -5° 59'$) was published by Plaskett in *Astrophysical Journal*, volume XXX, 373, 1909. On a fine-grained plate, No. 4847 taken Feb. 20·469, 1912, five lines belonging to the secondary component were measured and from these a ratio of the masses of 0·58 was obtained. Unlike ψ Orionis the *K*-line velocity seems constant, or at least of very small range. The weighted mean velocity for 30 plates, using the wave-length 3933·825, is + 30·1 km. per second, agreeing closely with that for the velocity of the system, + 21·3 km. per second. Here, as in ψ Orionis, the weights published are four times those given at measurement.

VELOCITY *K*-LINE

Plate	Velocity	Weight	Plate	Velocity	Weight
1076	+12·6	2	1162	+16·1	2
1077	39·6	3	1170	23·2	4
1078	43·6	3	1190	24·4	4
1112	36·8	3	1194	35·6	2
1116	12·0	1	1201	55·2	1
1119	28·4	1	1207	17·2	1
1120	21·2	2	1212	43·7	4
1122	34·6	1	1213	43·6	3
1123	36·0	4	1219	37·7	2
1124	41·3	2	1263	19·9	3
1125	32·9	4	1266	11·0	2
1126	9·1	1	1275	26·7	2
1136	20·6	2	1277	18·2	2
1143	26·8	2	1278	38·4	2
1148	+27·6	4	4847	+32·9	2

30 CANIS MAJORIS

(1900, $\alpha = 7^h 14^m{\cdot}5$, $\delta = -24° 47'$, mag. 4·40, type 0e5)

This star was announced a spectroscopic binary by Frost in a footnote in *Astrophysical Journal*, XXIII, page 265. Later Lee gave the velocities of five plates in *Astrophysical Journal* XXXIX, page 45. Four measures are also given by Campbell in *Lick Observatory Bulletin*, 199. The star would be a profitable and easy one to work up here but for its southern declination.

Plate	Date, G.M.T.	Velocity	Lines
8383	1917, Dec. 11·833	+32	2
8408	1918, Jan. 3·733	+71	2
8453	Feb. 20·604	+ 1	3

MEASURES OF 30 CANIS MAJORIS

λ	8383		8408		8453									
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527					+28·6	1/8								
4471·676	+25·7	1/4	+76·2	1/2	15·4	1/2								
4340·634	+ 8·6	1/8	+49·7	1/4	+ 6·8	1/2								
Weighted mean	+ 20·00		+ 67·37		+ 13·07									
V_a	+ 11·96		+ 4·33		− 12·22									
V_d	− ·09		·00		− ·02									
Curv.	− ·28		− ·28		− ·28									
Radial Velocity	+ 31·6		+ 71·4		+ 0·6									

BOSS 2381

(1900, $\alpha = 8^h\ 46^m\cdot 6$, $\delta = -6° 49'$, mag. 5·60, type A2)

This star was announced as a spectroscopic binary by Adams in *Publications of the Astronomical Society of the Pacific*, XXVI, 261.

Our two measures follow:—

Plate	Date, G.M.T.	Velocity	Lines
7972	1917, Dec. 29·807	+49	9
8000	1918, Jan. 16·773	+33	4

MEASURES OF BOSS 2381

λ	7972		8000											
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584·018			+ 1·6	¼										
4572·156	+42·3	¼												
4563·939	25·5	¼												
4549·766	30·0	¾	24·6	½										
4481·400	43·9	1	35·5	¾										
4340·634	16·8	½												
4325·939	12·2	½												
4271·760	40·4	½	+ 8·2	¼										
4233·328	40·8	½												
4045·975	+28·0	½												
Weighted mean	+ 32·04		+ 23·66											
V_a	+ 17·06		+ 9·48											
V_d	·00		− ·04											
Curv.	− ·28		− ·28											
Radial Velocity	+ 48·8		+ 32·8											

36 LYNCIS

(1900, $\alpha = 9^h\ 07^m\cdot 3$, $\delta = +\ 43° \ 38'$, mag. 5·30, type B8)

While no range is shown in our measures, Jordan at the Allegheny Observatory gets a range of 20 km. on 7 plates—from + 4 to + 24—so the star is probably a spectroscopic binary as the lines are narrow and well adapted for measurement.

Plate	Date, G.M.T.	Velocity	Lines	Weight
6939	1915, April 20·603	+13·8	6	4
6953	" 26·612	+19·5	3	2
6978	May 10·577	+17·5	9	5
6993	" 14·575	+15·2	6	4
8511	1918, April 24·592	+10·7	4	2

MEASURES OF 36 LYNCIS

λ	6939		6953		6978		6993		8511					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572·156					+63·1	½								
4549·766	+31·6	1	+47·9	½	41·4	¾	+34·4	¼	+45·6	½				
4481·400	38·5	¾	41·2	½	30·0	¾	36·4	½	26·4	¼				
4340·634	50·6	¾			38·0	1	45·0	1	43·6	¼				
4338·084							41·5	½						
4233·328					55·3	½			+32·7	½				
4131·047					52·5	¼								
4128·211	42·0	½	+50·4	½	54·3	¼								
4101·890	44·7	½			46·6	½	46·4	¾						
3933·825	+42·2	½			+36·8	½	+32·7	½						
Weighted mean	+ 40·70		+ 46·50		+ 43·80		+ 41·03		+ 37·73					
V_a	− 26·44		− 26·59		− 25·89		− 25·42		− 26·58					
V_d	− ·13		− ·17		− ·17		− ·18		− ·13					
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28					
Radial Velocity	+ 13·8		+ 19·5		+ 17·5		+ 15·2		+ 10·7					

ζ LEONIS

(1900, $\alpha = 10^h\ 11^m \cdot 1$, $\delta = +23° 55'$, mag. 3·65, type F)

This star was announced a binary by Campbell in *Lick Observatory Bulletin*, 199. Our measures follow:

Plate	Date, G.M.T.	Velocity	Lines
5325	1913, Jan. 27·734	−12·7	10
5331	" 28·722	−16·3	9
5342	Feb. 3·857	− 8·5	5

MEASURES OF ζ LEONIS

λ	5325		5331		5342									
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4395·286	−26·0	½												
4352·006	14·7	¼	−36·4	½										
4340·634	14·4	¾	11·6	½	− 3·7	½								
4325·939			24·8	½										
4271·760	18·9	½	29·3	½	−11·3	½								
4198·494	4·8	½	0·8	½										
4143·928	40·5	½	36·2	½	−30·4	½								
4101·890	20·7	¾	25·0	½										
4063·756	39·1	½			−29·0	½								
4045·975	24·5	½	36·2	¾										
4005·597	−18·6	½	−21·4	½	+ 3·7	½								
Weighted mean	− 22·11		− 25·24		− 14·12									
V_a	+ 9·64		+ 9·13		+ 6·09									
V_d	+ ·07		+ ·08		− ·17									
Curv.	− ·28		− ·28		− ·28									
Radial Velocity	− 12·7		− 16·3		− 8·5									

π 8 VIRGINIS

(1900, $\alpha = 11^h\ 55^m{\cdot}7$, $\delta = +\ 7°\ 10'$, mag. 4·57, type A3)

This star was announced a spectroscopic binary by Albrecht in *Lick Observatory Bulletin*, V, 175, from three plates in 1909 giving a range from + 18 to − 21. In *Astrophysical Journal*, vol. XXXIX, 46, Lee gives the measures of four plates made in 1906, 1907 and 1909 showing a variation from + 6 to − 33. Two plates were made here in 1910 and their measures published in the Chief Astronomer's report for 1911. Their velocities are slightly changed in the table below to agree with the different wave-lengths used in the recent measures. The thirteen additional plates secured all give quite negative velocities, and it would appear that the time when positive velocities are possible is very short relative to the whole period, a condition which would obtain if the eccentricity were fairly high and ω around zero. The velocity of the system would seem to be about 20 km. per sec. negative. The lines are only fair for measurement on our single-prism plates. The measures follow.

Plate	Date, G.M.T.	Velocity	Lines
3349	1910, Mar. 18·868	−26·0	3
3383	April 11·792	21·8	3
8066	1917, Feb. 18·806	16·9	12
8078	" 27·830	26·4	10
8085	Mar. 1·751	35·8	13
8094	" 2·810	29·8	9
8133	" 30·727	26·4	6
8136	April 3·601	35·2	6
8139	" 8·590	35·7	9
8143	" 10·642	44·2	8
8147	" 16·753	30·7	9
8152	" 22·578	30·2	10
8155	" 23·702	42·5	7
8159	" 24·676	30·7	7
8166	May 13·725	−33·7	4

MEASURES OF $\dot{\pi}$ 8 VIRGINIS

λ	3349 Vel.	3349 Wt.	3383 Vel.	3383 Wt.	8066 Vel.	8066 Wt.	8078 Vel.	8078 Wt.	8085 Vel.	8085 Wt.	8094 Vel.	8094 Wt.	8133 Vel.	8133 Wt.
4584·018	−31·9	¼												
4549·743	18·2	½	−29·6	¾	−39·8	½	−35·4	¼	−46·6	½	−42·6	½	−45·3	½
4534·158									65·0	½				
4515·508											25·8	¼		
4501·417									29·6	½	48·7	¼		
4481·477	−27·5	¾			26·5	½	40·8	½	44·7	½	43·4	½		
4395·155									55·8	¼	38·2	¼		
4340·645			0·0	1½	47·1	½	46·3	½	53·7	½	41·4	½	−37·7	½
4325·698					32·2	½	22·9	½					+ 3·7	½
4307·974									41·0	½			−22·9	½
4290·053					36·5	½	10·0	½			17·5	¼		
4282·584													+14·3	½
4271·765					17·2	½			22·6	½				
4236·000							29·8	½						
4233·425					39·2	½	62·4	½	48·4	½	34·5	¼	−34·3	½
4227·107							22·3	½						
4215·733											−35·5	½		
4198·677					8·4	½			19·2	½				
4143·839			− 3·1	¼	29·1	½	36·8	½	65·3	½				
4071·865									37·8	¼				
4063·730					40·6	½								
4045·940					23·4	½			−41·2	¼				
4005·414					−23·2	½	−45·6	½						
Weighted mean	− 25·13		− 9·19		− 30·27		− 35·23		− 43·74		− 37·23		− 20·55	
V_a	− 0·35		− 12·10		+ 13·60		+ 9·24		+ 8·20		+ 7·76		− 5·44	
V_d	− ·26		− ·21		− ·02		− ·12		+ ·02		− ·09		− ·09	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 26·0		− 21·8		− 16·9		− 26·4		− 35·8		− 29·8		− 26·4	

MEASURES OF π 8 VIRGINIS—*Concluded*

λ	8136		8139		8143		8147		8152		8155		8159	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584·018							−11·5	¼	−22·7	½				
4572·190	−21·1	½	−11·1	¼									− 9·6	½
4563·939					−49·7	¼								
4549·743	19·1	½			34·6	¼	24·5	½	− 8·7	½	−27·5	½	+17·6	½
4481·477	23·5	¼	26·4	½	32·7	¼	23·9	¼	−10·2	¾	33·9	½	−30·2	½
4351·977							14·6	¼						
4340·645	5·2	¼	13·2	½	33·8	½	14·4	¼	−15·0	½	10·6	½	−24·5	½
4325·698					21·2	¼	31·6	¼			18·3	½	−27·0	½
4307·974					38·6	¼			− 7·8	½	29·2	½	+12·4	¼
4300·211	52·1	½												
4294·359											22·9	½		
4290·053			34·0	¼										
4282·584									+10·6	½				
4246·996									− 5·2	½				
4236·000											−30·8	½		
4233·425			18·2	¼			10·6	¼	−12·2	½			−16·1	¼
4227·107			38·4	¼										
4215·733			31·4	¼										
4101·898			21·4	¼	23·9	¼								
4071·865					−21·7	¼	0·0	½	−37·9	½				
4045·940	−26·9	¼	−38·5	¼			−18·1	¼	−23·2	½				
Weighted mean	− 26·67		− 24·84		− 32·20		− 15·82		− 13·10		− 24·74		− 12·57	
V_a	− 8·36		− 10·73		− 11·69		− 14·43		− 16·90		− 17·35		− 17·74	
V_d	+ ·14		+ ·14		+ ·03		− ·21		+ ·09		− ·16		− ·11	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 35·2		− 35·7		− 44·2		− 30·7		− 30·2		− 42·5		− 30·7	

16 COMÆ

(1900, $\alpha = 12^h\ 22^m{\cdot}0$, $\delta = +\ 27°\ 22'$, mag. 5·04, type A2)

The hydrogen lines and the calcium *K* are very strong in this spectrum, the magnesium λ 4481 fairly strong, while numerous other metallic lines are faint and hard to measure. The results, which are the means of two independent measures, do not establish a variable velocity.

Plate	Date, G.M.T.	Velocity	Lines
6941	1915, April 20·666	± 0	11
6974	May 9·704	− 4	11
6995	" 14·676	−13	14
7062	June 17·594	− 4	15

MEASURES OF 16 COMÆ

λ	6941		6974		6995		7062							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584·018							+15·7	½						
4572·190			+10·4	¼										
4549·743	+ 2·1	½	+17·6	½	+ 2·0	½	+26·2	¾						
4534·158							+34·1	½						
4508·445							− 6·9	½						
4481·477	+14·0	½	+19·2	½	+17·2	½	+31·8	¾						
4415·345							+39·6	½						
4404·861							+30·8	½						
4351·977	+43·0	¼												
4340·645	+26·0	1	+ 3·1	½	− 0·8	¼	+34·3	½						
4325·698					+ 4·8	¼	+30·3	¾						
4307·974	+ 5·8	½												
4250·586							+33·3	½						
4233·425	+32·5	½	+21·0	½	+25·6	½								
4227·107					−21·6	¼								
4202·192			+28·1	¾	+31·9	¼								
4198·677			+28·4	¼	+13·8	¼								
4143·839							− 4·5	¾						
4128·211	+36·5	¼			+18·6	½								
4101·898	− 1·6	½	+ 5·6	¼	+ 2·4	¼	+40·0	¼						
4071·865					+17·2	¼	+25·9	½						
4063·730	− 2·8	½	+18·1	¼	+ 4·5	¼	− 0·9	½						
4045·940	+26·1	¼	+29·0	½	+ 9·0	¼								
4005·414							+20·1	½						
3933·825	+10·6	½	− 3·8	¼	− 4·0	¼								
Weighted mean	+ 15·73		+ 17·89		+ 10·24		+ 22·96							
V_a	− 15·36		− 21·28		− 22·48		− 26·04							
V_d	− ·11		− ·16		− ·16		− ·16							
Curv.	− ·28		− ·28		− ·28		− ·28							
Radial Velocity	± 0·0		− 3·8		− 12·7		− 3·5							

12 CANUM VENATICORUM

(1900, $\alpha = 12^h 51^m \cdot 4$, $\delta = +38° 52'$, mag. 5·39, type Ap)

This is the fainter of the pair No. 6313 in Burnham's General Catalogue, whose distance apart of 20″ seems to be constant. The stars have a common proper motion of 0″·257, and thus, if the components of the pair should differ appreciably in their radial velocities, it would suggest a binary character for at least one of them. For the brighter star Campbell quotes a velocity of − 1·6 km. per sec. in *Lick Observatory Bulletin*, 211, and Hnatek in *A.N.*, 197, 185, gives five velocities, the mean of which is + 2·0 km. per sec. Thus, a velocity in the neighbourhood of ± 0 km. per sec. may be accepted for this star. For the fainter star, here dealt with, Ludendorff gives a velocity of − 0·3 km. per sec., being the mean of 12 accordant plates and agreeing well with the result for the main star. Our results, however, reveal a variable velocity, as either the first or second plate, both of which have quite sharp and well measurable lines, gives a velocity too divergent from the other measures to consider it as constant.

Plate	Date, G.M.T.	Velocity	Lines
7028	1915, May 30·613	−14·8	16
7104	July 15·616	−21·0	14
8079	1917, Feb. 27·884	− 3·6	10
8086	Mar. 1·812	− 8·0	12

MEASURES OF 12 CANUM VENATICORUM (fainter)

λ	7028		7104		8079		8086							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584·018	− 8·9	1					−18·1	¼						
4572·156	+29·3	½	− 2·0	½	+ 5·8	½	−11·3	½						
4563·939	+29·2	1			−14·4	½								
4558·827	+ 8·0	½												
4549·766	+10·7	½	− 6·5	¼	−10·6	½	−20·5	½						
4534·139					−11·5	½								
4481·400					+ 4·0	½								
4468·663	+21·2	1	+15·0	½										
4415·301	− 8·0	½	+ 7·8	¾										
4404·927	+ 9·7	1			−11·8	½	−15·9	½						
4395·286	+ 4·0	½												
4383·720					−16·6	½								
4352·006			− 9·6	½			−26·4	½						
4340·634			−10·3	¼			+ 9·7	¼						
4325·939			− 7·5	1	−19·6	½	− 8·0	¼						
4308·081	+ 7·5	1	− 3·6	½			−16·5	½						
4294·301			−10·8	½										
4289·915							−13·2	¼						
4271·760	+10·0	1	+ 7·3	½			−21·8	½						
4260·640	−10·6	1												
4250·616	+ 1·3	½	+18·6	½										
4236·107			− 8·8	½			−16·5	¼						
4233·328	+ 6·2	½	+ 1·2	½			+13·5	¼						
4215·668					−11·9	½								
4202·198	+ 1·1	1												
4143·928			− 9·4	½	− 4·5	½								
4045·975	+ 9·5	½												
Weighted mean	+ 7·84		− 0·95		− 9·11		− 12·84							
V_a	− 21·65		− 19·52		+ 5·92		+ 5·18							
V_d	− ·09		− ·22		− ·11		− ·02							
Curv.	− ·28		− ·28		− ·28		− ·28							
Radial Velocity	− 14·8		− 21·0		− 3·6		− 8·0							

τ 93 VIRGINIS

(1900, $\alpha = 13^h\ 56^m\cdot 6$, $\delta = +2°\ 02'$, mag. 4·34, type A2)

The spectrum of this star consists of broad hydrogen lines and calcium *K*, while hazy ill-defined λ 4481 and λ 4549 are also seen. Occasionally traces of other metallic lines appear, but the measures are confined to the ones above mentioned. While the range of 46 km. obtained from the measures might suggest a real variation in the radial velocity, the writer is inclined to ascribe the greatest portion of it at least to errors of measurement. Treating it as of constant velocity, we get a value − 2 km. per sec. Campbell in *L. O. B.*, 211, uses the value − 10: in his statistical treatment of the velocities of A-type stars.

Plate	Date, G.M.T.	Velocity	Lines
1342	1908, Feb. 21·88	− 9	5
1382	Mar. 4·86	+18	3
1389	" 9·81	+10	3
1399	" 16·83	− 3	3
1510	April 22·82	−12	3
1535	May 18·61	−26	3
1570	June 3·65	−15	3
2417	1909, Mar. 22·82	− 1	4
2453	" 31·80	− 1	2
2502	April 19·84	+21	2
2512	" 23·77	+ 2	3
2532	" 28·80	−20	2

MEASURES OF τ VIRGINIS

λ	1342		1382		1389		1399		1510		1535		1570	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	....	....	....	....	....	....	....	....	....	....	....	....	−13·4	¼
4549·766	....	....	....	....	....	....	....	....	−10·4	⅛	....	....	....	....
4481·400	−49·8	¼	+17·3	¼	+18·1	⅛	....	....	−22·3	⅛	....	....	....	....
4340·634	40·4	½	−12·1	½	− 6·8	1¼	−28·6	¼	+ 4·5	⅛	−16·0	½	+ 5·4	½
4101·890	28·8	½	+ 0·9	¼	−31·7	¼	11·6	½	....	....	13·4	¼	....	....
3970·177	13·6	½	....	....	....	....	....	....	....	....	....	....	....	....
3933·825	−43·4	¼	....	....	....	....	−20·2	¼	....	....	−25·5	½	+27·0	¼
Weighted mean	− 32·34		− 1·51		− 8·74		− 18·00		− 9·40		− 19·28		+ 6·10	
V_a	+ 23·96		+ 19·89		+ 17·97		+ 15·02		− 1·90		− 6·73		− 20·61	
V_d	− ·04		− ·04		+ ·04		− ·04		− ·20		+ ·04		− ·12	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 8·7		+ 18·1		+ 10·0		− 3·3		− 11·8		− 26·2		− 14·9	

MEASURES OF τ VIRGINIS—*Concluded*

λ	2417		2453		2502		2512		2532					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	− 6·6	⅛												
4549·766							+16·7	¼						
4481·400	+ 6·5	⅛	+ 4·5	½	+24·3	½	+19·6	¼						
4340·634	−22·6	½	−22·4	½	+21·1	½	− 7·3	½	−19·7	½				
4101·890	− 0·6	⅛							+11·2	⅛				
Weighted mean	− 12·89		− 9·00		+ 22·74		+ 5·42		− 13·52					
V_a	+ 12·45		+ 8·23		− 1·09		− 3·05		− 5·49					
V_d	− ·04		− ·08		− ·22		− ·10		− ·23					
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28					
Radial Velocity	− 0·8		− 1·1		+ 21·2		+ 2·0		− 19·5					

33 BOÖTIS

(1900, $\alpha = 14^h\ 35^m \cdot 1$, $\delta = +\ 44° \ 50'$, mag. 5·39, type A)

This star was announced a spectroscopic binary by Lee, in *Astrophysical Journal*, XXXIX, page 41, from three plates giving a range of 36 km. On our plates the lines do not seem to be sufficiently dependable to attempt its orbit.

Plate	Date, G.M.T.	Velocity	Lines
6927	1915, April 14·742	+ 9	4
8187	1917, May 30·681	−15	1

MEASURES OF 33 BOÖTIS

λ	6927 Vel.	6927 Wt.	8187 Vel.	8187 Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·743	−13·2	½												
4481·477	+15·7	½	− 0·7	½										
4340·645	+23·7	½												
3933·825	+22·0	½												
Weighted mean	+ 12·05		− 0·70											
V_a	− 2·95		− 13·71											
V_d	+ ·02		− ·08											
Curv.	− ·28		− ·28											
Radial Velocity	+ 8·8		− 14·8											

10 SERPENTIS

(1900, $\alpha = 15^h 23^m{\cdot}6$, $\delta = +2° 12'$, mag. 5·12, type A5)

The lines in this spectrum are very diffuse and ill-defined. Plate 7728 is much underexposed, so that the star's variable velocity is not established by these measures.

Plate	Date, G.M.T.	Velocity	n	Weight
7030	1915, May 30·709	−23	7	2
7082	July 1·551	−30	7	2
7091	" 9·546	−35	10	3
7728	1916, " 13·545	− 4	5	2

MEASURES OF 10 SERPENTIS

λ	7030		7082		7091		7728							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584·191							+29·7	½						
4549·766	−13·0	¼	−32·6	¼	−12·2	¼	−11·6	¼						
4481·400	−17·0	¼	− 1·8	¼	−19·2	¼	+49·9	½						
4468·663	− 0·1	¼												
4352·006			+ 1·3	¼										
4340·634	+ 1·6	¼	−10·0	¼	+ 8·7	¼								
4325·939	−19·4	¼	−12·1	¼	−20·6	¼	− 1·1	½						
4308·081					+17·4	¼								
4289·915					− 0·8	¼								
4233·328	−18·4	¼	−11·0	¼	−17·9	¼								
4227·010	−28·1	¼					+21·8	¼						
4198·494					+ 1·2	¼								
4143·928					−22·2	¼								
4045·975			+ 5·5	¼	−43·3	¼								
Weighted mean	− 13·47		− 8·66		− 10·89		+ 21·20							
V_a	− 9·42		− 21·34		− 23·48		− 24·55							
V_d	− ·09		− ·04		− ·06		− ·09							
Curv.	− ·28		− ·28		− ·28		− ·28							
Radial Velocity	− 23·3		− 30·3		− 34·7		− 3·7							

12 CORONÆ BOREALIS

(1900, $\alpha = 15^h\ 52^m{\cdot}1$, $\delta = +\ 38°\ 14'$, mag. 5·47, type A)

The hydrogen lines in this star are fairly well defined, the other lines are more or less diffuse.

Plate	Date, G.M.T.	Velocity	Lines	Weight
6982	1915, May 10·810	−13·9	10	4
6996	" 14·740	−13·9	14	4
7036	" 31·700	−13·0	10	6

MEASURES OF 12 CORONÆ BOREALIS

λ	6982		6996		7036									
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	− 4·4	½			−31·0	½								
4481·400	+ 4·8	¼	−15·6	¼	+ 5·7	¾								
4395·286	− 6·8	¼	− 9·1	¼										
4352·006	− 8·8	¼												
4340·634	− 7·8	½	+ 1·1	½	+11·0	1								
4325·939	−20·9	½	− 4·6	¼	−16·6	½								
4289·915	− 5·2	¼	− 7·2	¼	+40·0	½								
4271·760	−13·2	½	+ 8·7	¼										
4233·328			+ 6·3	¼										
4227·010			− 8·8	¼										
4198·494			−14·3	½										
4143·928			−23·4	¼	−30·3	1								
4101·890	−16·0	½			− 0·5	½								
4077·885			− 8·4	¼	−12·3	½								
4071·901			−29·2	¼	−25·7	½								
4063·756			−31·4	¼										
4045·975	−18·0	¾	−14·6	½										
4005·355					+11·4	½								
Weighted mean	− 11·44		− 10·42		− 5·17									
V_a	− 2·07		− 3·15		− 7·53									
V_d	− ·11		− ·02		− ·02									
Curv.	− ·28		− ·28		− ·28									
Radial Velocity	− 13·9		− 13·9		− 13·0									

21 OPHIUCHI

(1900, $\alpha = 16^h 46^m \cdot 4$, $\delta = +1° 23'$, mag. 5·47, type A)

The lines λ 4549 and λ 4481 are fairly good lines in this spectrum. Plate 7009 is underexposed.

Plate	Date, G.M.T.	Velocity	Lines	Weight
6985	1915, May 11·777	−27	4	2
7009	" 23·765	−25	3	1
7037	" 31·773	−33	4	1
7063	June 17·645	−32	6	3

MEASURES OF 21 OPHIUCHI

λ	6985		7009		7037		7063							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584·191			−51·2	¼	−43·7	⅛								
4549·766	−37·1	¾	36·0	½	31·8	⅛	−29·0	½						
4481·400	40·7	¾	− 9·4	½	31·7	½	12·9	¾						
4340·634	33·8	¼												
4325·939							17·9	¼						
4308·081							23·2	¼						
4233·328					−29·4	¼	22·5	½						
4045·975	−22·8	¼					−37·7	¾						
Weighted mean	− 36·30		− 28·40		− 32·64		− 24·60							
V_a	+ 9·38		+ 4·05		+ 0·40		− 7·18							
V_d	·00		− ·04		− ·10		+ ·07							
Curv.	− ·28		− ·28		− ·28		− ·28							
Radial Velocity	− 27·2		− 24·7		− 32·6		− 32·0							

101 HERCULIS

(1900, $\alpha = 18^h\ 04^m{\cdot}6$, $\delta = +20^\circ\ 01'$, mag. 5·24, type A2)

The lines in this spectrum are excellent for measurement. No variation is indicated by the measures which follow.

Plate	Date, G.M.T.	Velocity	Lines	Weight
6976	1915, May 9·812	−16·6	10	10
6990	" 13·770	−21·8	12	12
7024	" 29·711	−21·3	15	12
7075	June 25·642	−19·7	17	15

MEASURES OF 101 HERCULIS

λ	6976		6990		7024		7075							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·746	−36·2	1	−33·7	1	−30·9	1	− 6·6	1						
4534·139							28·1	½						
4481·464	29·8	1	40·2	1	34·4	1	16·9	1						
4415·333					24·0	1	7·8	½						
4404·857							22·9	1						
4395·147							10·1	1						
4351·991							8·8	½						
4340·667	36·8	1	32·2	1										
4325·707	57·0	1	52·7	1	38·7	½	30·0	1						
4307·980					46·7	½	31·5	1						
4290·070					41·0	½	22·5	1						
4271·645					31·3	1	21·4	1						
4250·687							28·0	1						
4235·991					25·7	½	18·6	1						
4233·421	28·3	1	24·7	1	32·0	1	19·0	1						
4227·124					31·3	½								
4202·278					37·5	½								
4198·719	24·3	1	39·4	1										
4143·839	26·0	1	32·8	1	24·6	1	7·0	1						
4101·890			37·6	1										
4077·862	35·9	1	33·0	1										
4071·861							23·5	1						
4063·706			30·5	1	19·3	1								
4045·929	18·0	1	37·7	1	26·0	1	−13·8	1						
4005·402	−18·6	1	−29·2	1	−26·6	1								
Weighted mean	− 31·09		− 35·31		− 29·94		− 18·97							
V_a	+ 14·82		+ 13·73		+ 8·85		− 0·60							
V_d	− ·04		+ ·10		+ ·11		+ ·11							
Curv.	− ·28		− ·28		− ·28		− ·28							
Radial Velocity	− 16·6		− 21·8		− 21·3		− 19·7							

BOSS 4669

(1900, $\alpha = 18^h\ 22^m\cdot 1$, $\delta = +\ 29°\ 46'$, mag. 5·71, type A)

While the two plates secured are not sufficiently exposed they show the stellar lines to be sharp and very suitable for measurement. The star has been announced as a binary by Adams.

Date, G.M.T.	Velocity	Lines
1917, Sept. 24·551	−7·6	10
" 26·557	−9·8	6

MEASURES OF BOSS 4669

λ	8305		8310											
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584·018	+ 4·0	¼												
4572·190	23·0	¼												
4549·743	17·8	1	+ 8·7	½										
4534·158			− 2·1	½										
4481·477	1·3	1	+ 4·4	1										
4325·698	10·0	½	+16·1	½										
4236·000	0·2	½												
4233·425	24·2	¼												
4143·839	11·5	¾	+11·5	¾										
4071·865	14·4	½												
4045·940	+10·9	½	+14·4	½										
Weighted mean	+ 10·60		+ 8·43											
V_a	− 17·74		− 17·80											
V_d	− ·14		− ·15											
Curv.	− ·28		− ·28											
Radial Velocity	− 7·6		− 9·8											

ADDITIONAL OBSERVATIONS OF 50 DRACONIS

The orbit of this star was published by the writer in the *Dominion Observatory Publications*, volume II, page 123, and therein it was indicated that further observations would be made to improve the value of the period which was determined solely from one season's observations.

To the 32 plates obtained in 1914 were added eight in 1915 and twelve in 1916, and from these 52 plates a solution was made which changed the value of the period from 4·120 days to 4·118 days and made small changes in the other elements. Eight plates have been obtained at odd times since then and these would indicate an even smaller value for the period, namely 4·1175, which is thus given as the best value from all the observations.

With the exception of T, the time of periastron passage, which was adjusted to conform to the revised period, the other elements from the solution of the 52 plates have been retained and are as follows:—

$$
\begin{aligned}
P &= 4{\cdot}1175 \text{ days} \\
e &= {\cdot}012 \pm {\cdot}009 \\
K_1 &= 79{\cdot}12 \text{ km.} \pm 0{\cdot}97 \text{ km.} \\
K_2 &= 83{\cdot}90 \text{ km.} \pm 0{\cdot}97 \text{ km.} \\
\gamma &= -\,8{\cdot}79 \text{ km.} \pm 0{\cdot}49 \text{ km.} \\
\omega_1 &= 107^\circ{\cdot}6 \pm 8^\circ{\cdot}9 \\
\omega_2 &= 287^\circ{\cdot}6 \pm 8^\circ{\cdot}9 \\
T &= \text{J. D. } 2{,}420{,}293{\cdot}519 \pm {\cdot}102 \\
a_1 \sin i &= 4{,}480{,}000 \text{ km.} \\
a_2 \sin i &= 4{,}750{,}600 \text{ km.} \\
m_1 \sin^3 i &= {\cdot}95\odot \\
m_2 \sin^3 i &= {\cdot}90\odot
\end{aligned}
$$

The probable error of a plate is $\pm$ 4·6 km. per sec. for component I, and $\pm$ 4·8 km. per sec. for component II. The table of measures following is a continuation of the table on page 123 of the volume mentioned above, but the phases there given, if used, should be revised to suit the new P and T.

ADDITIONAL MEASURES OF 50 DRACONIS

Plate	Observer*	Date		Julian Date	Phase	Component I				Component II			
						n	Wt.	Vel.	O–C	n	Wt.	Vel.	O–C
		1915											
7124	C	July	26	2,420,705·770	·501	4	3	− 81·6	− 3·0	5	4	+ 58·5	− 6·7
7133	H	"	29	708·721	3·452	2	2	+ 44·0	− 0·3	4	3	− 59·7	− 5·2
7144	H	Aug.	9	719·682	2·061	5	4	− 8·5	......	...	...	......	......
7163	Y	"	23	733·611	3·639	2	1·5	+ 45·6	+19·2	3	2	− 49·8	− 4·8
7179	Y	"	27	737·632	3·541	2	1·5	+ 24·9	−11·7	2	1·5	− 55·4	+ 1·0
7272	Y	Sept.	21	762·562	3·766	5	4	− 22·4	......	...	...	......	......
7282	H	"	22	763·553	·639	4	3	− 83·8	+ 0·8	4	3	+ 83·2	+11·4
7290	H	"	27	768·610	1·579	2	1	− 50·9	− 8·0	2	1	+ 22·2	− 5·7
		1916											
7665	H	May	24	2,421,008·625	2·779	4	3	+ 80·5	+13·3	4	2·5	−100·7	−13·4
7671	Y	"	26	010·610	·646	3	2	− 97·7	−14·3	4	2·5	+ 79·7	+ 8·6
7674	Y	"	28	012·694	2·730	2	1	+ 71·0	+ 5·6	5	3	− 84·2	+ 2·2
7682	H	June	1	016·650	2·569	8	6	+ 71·3	+14·0	8	5	− 70·0	+ 9·0
7720	H	July	6	051·595	·456	6	4	− 66·0	+ 6·3	3	2	+ 75·1	+15·7
7723	H	"	8	053·682	2·543	2	1·5	+ 59·5	+ 4·3	4	3	− 80·6	− 3·5
7726	H	"	9	054·778	3·639	1	1	+ 27·8	− 2·9	...	...	......	......
7749	H	"	21	066·763	3·272	8	5	+ 62·8	+ 2·1	8	5	− 78·8	+ 3·7
7762	H	"	26	071·612	4·003	9	6	+ 5·9	......	...	...	......	......
7769	H	Aug.	1	077·760	1·916	14	6	− 4·5	......	...	...	......	......
7785	H	"	15	091·703	3·507	5	3	+ 36·0	− 7·8	5	3	− 65·2	− 1·3
7788	H	"	16	092·573	·259	9	6	− 59·6	− 5·0	9	6	+ 49·6	+ 8·7
		1917											
8210	H	June	27	407·691	2·447	2	1·5	+ 58·2	+ 5·4	3	2	− 64·2	+ 9·0
8214	H	July	2	412·661	3·300	1	1	+ 49·1	− 6·6	2	1·5	− 76·0	+ 1·0
8279	H	Sept.	3	475·603	·362	7	5	− 64·8	+ 5·1	8	5	+ 57·2	+ 0·3
8301	H	"	18	490·570	2·976	6	5	+ 73·8	+ 4·5	5	4	− 92·9	− 1·3
8307	H	"	24	496·698	·869	2	2	− 85·2	+ 2·2	2	2	+ 59·2	−15·0
		1918											
8654	H	Sept.	24	861·650	3·481	3	2	+ 39·5	− 0·3	2	1·5	− 54·5	+ 5·8
8658	H	"	30	867·640	1·236	3	2	− 76·9	− 4·0	3	2	+ 45·8	−12·7
		1919											
8725	H	Mar.	13	2,422,031·862	·758	1	1	−103·3	−15·5	1	1	+ 61·3	−13·5

*C = Cannon; H = Harper; Y = Young

MEASURES OF 50 DRACONIS (primary)

λ	7124 Vel.	7124 Wt.	7133 Vel.	7133 Wt.	7144 Vel.	7144 Wt.	7163 Vel.	7163 Wt.	7179 Vel.	7179 Wt.	7272 Vel.	7272 Wt.	7282 Vel.	7282 Wt.
4549					−15·3	½					−38·3	½	−111·5	½
4481					+ 5·4	½	+29·5	¼			25·3	½		
4340			+45·9	¾	−12·3	½					19·9	½		
4308													94·2	¼
4250					−24·6	½								
4143	−89·6	½												
4101	62·5	¼											79·8	¼
4077	86·8	½							+18·2	¼	29·7	¾		
4063	79·8	½							+21·0	¾				
4045	101·5	½												
3933	−82·8	1½	+36·0	1	−15·8	½	+46·8	½			−21·9	¾	− 80·9	1½
Weighted mean	− 85·07		+ 40·30		− 12·52		+ 41·03		+ 20·30		− 26·80		− 88·20	
V_a	+ 3·87		+ 4·02		+ 4·38		+ 4·83		+ 4·93		+ 4·72		+ 4·69	
V_d	− ·09		− ·05		− ·05		− ·03		− ·05		− ·03		− ·05	
Curv.	− ·29		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 81·6		+ 44·0		− 8·5		+ 45·6		+ 24·9		− 22·4		− 83·8	

MEASURES OF 50 DRACONIS (primary)—*Continued*

λ	7290		7665		7671		7674		7682		7720		7723	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549									+85·5	½	−72·7	½	+64·8	½
4520									68·1	½				
4481			+71·1	½	−111·2	½	+78·6	¼			62·8	½	+49·1	½
4340									49·3	½	50·3	¼		
4271			116·1	¼							79·7	¼		
4260									61·6	¼				
4227					79·6	¼								
4143									70·3	¼				
4101							+64·6	¼						
4077									83·1	¼				
4045	−61·8	¼	88·9	¼	−86·2	¼			71·5	½	63·5	¼		
3933	−48·3	¼	+70·7	½					+79·5	¾	−84·5	¼		
Weighted mean	− 55·05		+ 81·33		− 97·00		+ 71·60		+ 71·57		− 68·50		+ 56·95	
V_a	+ 4·50		− 0·70		− 0·53		− 0·36		− 0·03		+ 2·70		+ 2·84	
V_d	− ·06		+ ·12		+ ·08		+ ·06		+ ·06		+ ·05		+ ·02	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 50·9		+ 80·5		− 97·7		+ 71·0		+ 71·3		− 66·0		+ 59·5	

MEASURES OF 50 DRACONIS (primary)—*Continued*

λ	7726		7749		7762		7769		7785		7788		8210	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584					−12·8	¼								
4563			+64·7	¼			+ 0·5	½						
4549					+17·1	¼	−24·6	¾						
4481			76·1	½	+ 2·9	½	−19·4	¾			−58·8	½	+58·0	½
4468			48·7	¼			+ 1·2	¾						
4415											56·9	¼		
4352							− 9·5	¾						
4340			55·4	½			−12·5	½			64·9	¼		
4325							−12·0	¾			77·4	¼		
4308					+ 4·0	½	+ 1·2	½						
4294							−11·7	¾						
4289							+ 8·6	½						
4271					− 9·2	¼					54·9	½		
4236					+ 8·6	¼	−21·1	½						
4233			73·2	¼	+20·9	¼	− 1·0	¾	+29·4	¼	47·4	½		
4215					−16·6	½								
4143			63·5	¼										
4077					+11·8	½	−10·7	¾						
4063							+ 1·0	½	22·7	¼	67·7	½		
4045			45·2	½					21·8	¼	71·9	½		
4005									52·2	¼				
3933	+25·2	¼	+61·2	½					+32·3	¼	−80·0	½	+53·3	¼
Weighted mean	+ 25·20		+ 59·44		+ 2·22		− 8·48		+ 31·68		− 64·03		+ 56·42	
V_a	+ 2·91		+ 3·65		+ 3·90		+ 4·19		+ 4·68		+ 4·71		+ 2·04	
V_d	− ·04		− ·05		+ ·03		− ·05		− ·05		+ ·02		+ ·03	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 27·8		+ 62·8		+ 5·9		− 4·5		+ 36·0		− 59·6		+ 58·2	

MEASURES OF 50 DRACONIS (primary)—*Continued*

λ	8214		8279		8301		8307		8654		8658		8725	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	....		−76·8	½	....		−122·3	½	....		−104·2	⅛	....	
4481	+46·7	¼	66·4	½	+64·9	1	− 67·6	¾	+31·2	¼	72·1	¼	−98·2	½
4415	....		....		78·6	½	....		....		....		....	
4340	....		68·8	¼	70·9	1	....		12·5	½	....		....	
4143	....		....		64·0	½	....		....		....		....	
4101	....		74·2	½	73·2	½	....		....		....		....	
4077	....		58·1	½	....		....		....		....		....	
4045	....		69·2	¼	....		....		....		....		....	
3933	....		−75·2	¼	+16·3	½	....		+59·2	½	− 78·2	¼	....	
Weighted mean	+ 46·70		− 69·45		+ 69·32		− 89·44		+ 34·88		− 80·96		− 98·20	
V_a	+ 2·40		+ 4·93		+ 4·78		+ 4·62		+ 4·84		+ 4·43		− 4·91	
V_d	+ ·03		− ·02		− ·04		− ·08		+ ·07		− ·07		+ ·09	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 49·1		− 64·8		+ 73·8		− 85·2		+ 39·5		− 76·9		− 103·3	

MEASURES OF 50 DRACONIS (secondary)—*Continued*

λ	7124		7124		7133		7163		7179		7282		7290	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	...	...	...	...	...	...	...	...	...	...	+70·0	¼	...	...
4534	...	...	...	...	...	...	−51·2	½	...	...	...	...	...	...
4340	...	...	...	...	−59·3	¾	...	...	...	...	...	...	...	...
4308	...	...	...	...	...	...	...	...	...	...	82·4	¼	...	...
4271	...	...	...	...	72·3	¼	...	...	...	...	...	...	...	...
4143	...	...	+65·9	½	...	...	60·3	¼	...	...	...	...	...	...
4101	+67·5	¼	...	...	...	...	...	...	...	...	84·3	¼	...	...
4077	...	...	63·9	½	...	...	...	...	−69·0	¼	...	...	...	...
4063	50·8	½	44·3	½	...	...	...	...	...	...	...	...	...	...
4045	44·4	1	47·0	½	...	...	...	...	−57·0	¾	...	...	+24·3	¼
3968	...	...	...	...	67·9	½	...	...	...	...	...	...	...	...
3933	+59·0	1½	+58·3	1½	−61·8	1	−54·5	½	...	...	+78·8	1½	+11·6	¼
Weighted mean	+ 53·44		+ 56·54		− 63·36		− 54·35		− 60·00		+ 78·84		+ 18·00	
V_a	+ 3·87		+ 3·87		+ 4·02		+ 4·83		+ 4·93		+ 4·69		+ 4·50	
V_d	− ·09		− ·09		− ·05		− ·03		− ·05		− ·05		− ·06	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 57·0		+ 60·0		− 59·7		− 49·8		− 55·4		+ 83·2		+ 22·2	

MEASURES OF 50 DRACONIS (secondary)—*Continued*

λ	7665		7671		7674		7682		7720		7723		7726	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549							−64·4	½	+51·7	½	−93·2	½		
4520							62·9	¼						
4481	−117·0	¼	+85·0	½	− 78·6	¼			74·9	½	84·6	½		
4340							60·5	¼						
4325											71·8	½		
4308	84·2	¼			91·3	½								
4271					106·0	¼								
4260					80·2	¼	81·8	¼						
4233			95·0	¼										
4227			73·6	¼										
4143							90·3	¼						
4077							83·5	¼						
4045	103·8	¼	+63·3	¼			51·9	½			−83·0	½		
3933	− 94·3	¼			− 54·7	¼	−77·8	½	+91·2	½			−39·2	¼
Weighted mean	− 99·80		+ 80·40		− 83·60		− 69·73		+ 72·60		− 83·15		− 39·20	
V_a	− 0·70		− 0·53		− 0·36		− 0·03		+ 2·70		+ 2·84		+ 2·91	
V_d	+ ·12		+ ·08		+ ·06		+ ·06		+ ·05		+ ·02		− ·04	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 100·7		+ 79·7		− 84·2		− 70·0		+ 75·1		− 80·6		− 36·6	

MEASURES OF 50 DRACONIS (secondary)—*Continued*

λ	7749		7785		7788		8210		8214		8279		8301	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4563	−98·0	½	....	....	....	....	....	....	....	....	....	....	....	....
4549	....	....	....	....	....	....	....	....	....	....	+40·9	¼	....	....
4481	74·8	¼	....	....	+28·1	½	−74·5	¼	−82·1	⅓	34·2	⅓	−105·8	½
4468	101·4	¼	....	....	....	....	....	....	....	....	....	....	....	....
4415	....	....	....	....	38·2	⅓	....	....	....	....	....	....	....	....
4352	64·0	¼	....	....	....	....	....	....	....	....	....	....	....	....
4340	84·1	¼	....	....	42·6	⅓	....	....	....	....	38·4	¼	93·8	1
4325	....	....	....	....	68·1	⅓	....	....	−75·5	½	....	....	....	....
4271	....	....	....	....	54·3	¼	....	....	....	....	....	....	....	....
4233	58·8	¼	−66·8	¼	54·1	¼	....	....	....	....	....	....	....	....
4143	67·8	¼	....	....	....	....	....	....	....	....	....	....	117·8	⅓
4101	....	....	....	....	....	....	....	....	....	....	75·0	⅓	85·7	⅓
4077	....	....	....	....	....	....	56·6	⅓	....	....	53·5	⅓	....	....
4063	....	....	54·9	¼	59·4	½	....	....	....	....	63·1	½	....	....
4045	....	....	70·4	¼	40·3	½	....	....	....	....	40·1	¼	....	....
4005	....	....	74·4	¼	....	....	....	....	....	....	....	....	....	....
3933	−87·7	½	−81·0	¼	+30·0	½	−76·5	¼	....	....	+60·0	¼	− 97·6	⅓
Weighted mean	− 82·16		− 69·50		+ 45·10		− 66·00		− 78·10		+ 52·53		− 97·40	
V_a	+ 3·65		+ 4·68		+ 4·71		+ 2·04		+ 2·40		+ 4·93		+ 4·78	
V_d	− ·05		− ·05		+ ·02		+ ·03		+ ·03		− ·02		− ·04	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 78·8		− 65·2		+ 49·6		− 64·2		− 76·0		+ 57·2		− 92·9	

MEASURES OF 50 DRACONIS (secondary)—*Concluded*

λ	8307		8654		8658		8725							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549	+ 47·4	¾	....	....	+41·3	¼	....	....	....	....	....	....	....	....
4481	+ 62·4	¾	−80·2	¼	43·2	¼	+66·4	½	....	....	....	....	....	....
3933	....	....	−48·6	½	+40·8	¼	....	....	....	....	....	....	....	....
Weighted mean	+ 54·90		− 59·13		+ 41·77		+ 66·40		....		....		....	
V_a	+ 4·62		+ 4·84		+ 4·43		− 4·91		....		....		....	
V_d	− ·08		+ ·07		− ·07		+ ·09		....		....		....	
$Cu_r v.$	− ·28		− ·28		− ·28		− ·28		....		....		....	
Radial Velocity	+ 59·2		− 54·5		+ 45·8		+ 61·3		....		....		....	

BOSS 5070

(1900, $\alpha = 19^h\ 47^m\cdot 2$, $\delta = +40° 20'$, mag. 5·62, type A)

This star was announced as a spectroscopic binary by Adams in the *Publications of the Astronomical Society of the Pacific*, vol. 26, page 261. From the measures, the period is evidently short. The *K* line of calcium does not share in the large oscillations of the other lines. Sufficient plates for an orbit have been secured at Allegheny and the star is dropped from our list.

Our measures follow.

Plate	Date, G.M.T.	Velocity	*n*	Weight
6804	1915, Feb. 18·941	−23	9	3
6842	Mar. 3·910	+19	10	4
6928	April 14·803	+88	7	3
8285	1917, Sept. 6·747	−86	5	2
8290	" 8·527	+ 4	6	2
8294	" 11·631	+67	7	3
8297	" 12·653	+73	4	2

MEASURES OF BOSS 5070

λ	6804		6842		6928		8285		8290		8294		8297	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4567·967	+11·5	¼	+ 6·6	¼	+ 99·5	¼								
4552·762	−26·3	¼	+24·4	¼	+101·6	½			+40·9	½	+77·4	¾	+ 58·4	½
4481·400	−12·0	¼												
4471·676	−33·6	¾	+18·7	½	+ 69·6	¼	−73·1	¾	−11·0	½	+82·1	¾	+115·5	¾
4388·100			+28·5	¼	+ 75·4	¼	−97·0	½	+18·3	½	+65·3	¼	+ 70·0	½
4340·634	−54·4	½	− 4·5	½	+ 43·0	½	−66·4	½	+16·1	½	+77·7	¾	+ 58·9	¼
4325·939			+21·7	½										
4267·301	−23·8	¼	+22·3	¼							+94·8	¼		
4143·928	−16·1	¼	− 1·9	½			−78·9	¼			+52·0	¼		
4101·890	−19·0	¼	+11·6	½	+ 54·6	½	−72·7	¼	− 1·9	¼				
4026·352					+ 88·4	½			+ 1·5	¼	+72·0	¼		
3933·825	[− 5·8	½]	[−29·0	½]	[− 6·5	½]								
Weighted mean	− 26·87		+ 12·31		+ 74·47		− 77·56		+ 12·76		+ 76·56		+ 82·80	
V_a	+ 4·07		+ 7·20		+ 13·99		− 7·74		− 8·13		− 8·78		− 8·99	
V_d	+ ·22		+ ·21		+ ·21		− ·21		+ ·07		− ·11		− ·13	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 22·9		+ 19·4		+ 88·4		− 85·8		+ 4·4		+ 67·4		+ 73·4	

13 VULPECULÆ

(1900, $\alpha = 19^h\ 49^m \cdot 2$, $\delta = +23° 50'$, mag. 4·50, type A)

This star was announced a binary by Lee, in *Astrophysical Journal*, XXXII, 307, from eight plates giving a range from − 15 to − 36. Campbell used as the velocity for the star, − 28. While the lines are in general fairly sharp there is a bare suspicion that $H\gamma$ on plate 8221 is double.

Plate	Date, G.M.T.		Velocity	Lines	Weight
8202	1917, June	18·714	−37·8	1	1
8218	July	5·740	−24·2	4	2
8221	"	6·690	−30·8	2	1
8222	"	14·678	−30·4	5	2
8225	"	15·777	−32·5	5	2
8228	"	16·691	−24·1	1	1

MEASURES OF 13 VULPECULÆ

λ	8202		8218		8221		8222		8225		8228			
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4584·018	......	...	......	...	......	...	−18·6	½	......	...	......	...	......	...
4549·743	......	...	−15·6	¼	......	...	+35·3	¼	−42·1	½	......	...	......	...
4481·477	−50·9	¾	44·0	½	−43·1	½	+51·5	½	+24·1	½	−28·1	¾	......	...
4340·645	......	...	25·8	¼	......	...	+33·9	½	+40·0	¼	......	...	......	...
4233·425	......	...	......	...	......	...	......	...	+41·5	¼	......	...	......	...
3933·825	......	...	−31·2	½	−28·6	¼	−36·6	½	−43·2	¼	......	...	......	...
Weighted mean	− 50·90		− 31·93		− 38·27		− 35·15		− 36·70		− 28·10		......	
V_a	+ 13·20		+ 7·99		+ 7·64		+ 4·96		+ 4·58		+ 4·20		......	
V_d	+ ·14		+ ·02		+ ·08		+ ·08		− ·08		+ ·04		......	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		......	
Radial Velocity	− 37·8		− 24·2		− 30·8		− 30·4		− 32·5		− 24·1		......	

BOSS 5535

(1900, $\alpha = 21^h\ 28^m\cdot3$, $\delta = +60°\ 01'$, mag. 5·52, type A)

This star is in Kapteyn's Area No. 18. It is listed as of A-type in *Harvard Annals*, vol. 50, but would more properly fall under the classification B2. Besides the hydrogen and helium series, there are the characteristic lines of this type at λλ 4089 and 4649 variously ascribed to argon, silicon and other substances. The third member of the group, that at λ 4116, does not appear on the plates. The three silicon lines λλ 4575·52, 4568·13 and 4552·89 are seen in the spectrum, the latter two being 0·5 as intense as $H\gamma$ or the helium λ 4471. The wave-lengths indicated for them are somewhat greater than the generally accepted values, but were adjusted to agree with the velocities obtained from the hydrogen and helium series. Other absorption lines, whose normal wave-lengths are approximately λλ 4366·9, 4620·5, 4630·7 and 4641·4, were noted but not used in the results.

Plate	Date, G.M.T.	Number of Lines	Velocity
8394	1917, Dec. 28·465	5	−28·3
8404	1918, Jan. 2·481	5	−18·7
8410	" 4·455	6	−19·4
8672	Oct. 23·605	7	−33·8

MEASURES OF BOSS 5535

λ	8394		8404		8410		8672							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4568·13−	−14·0	½	+19·1	¼	− 9·7	¼	−38·6	½	...	...	...	...	...	...
4552·89−	12·3	½	− 1·4	¼	− 5·3	½	31·0	½	...	...	...	...	...	...
4471·676	19·7	¾	−29·0	½	+ 1·8	½	22·3	¾	...	...	...	...	...	...
4388·100	19·6	¼	− 2·1	¼	− 0·9	½	26·4	¾	...	...	...	...	...	...
4340·634	−11·2	¼	+ 4·6	¼	−16·7	½	34·2	¾	...	...	...	...	...	...
4143·928	...	...	...	...	−18·4	¼	17·3	½	...	...	...	...	...	...
4121·016	...	...	...	...	...	...	−35·5	½	...	...	...	...	...	...
Weighted mean	− 15·84		− 6·20		− 6·96		− 29·01		...		...		...	
V_a	− 12·07		− 12·07		− 12·04		− 4·42		...		...		...	
V_d	− ·11		− ·14		− ·12		− ·09		...		...		...	
Curv.	− ·28		− ·28		− ·28		− ·28		...		...		...	
Radial Velocity	− 28·3		− 18·7		− 19·4		− 33·8		...		...		...	

Dominion Observatory
Ottawa
April, 1919.