

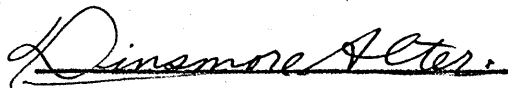
The SPECTROSCOPIC BINARY "E MONOCEROTIS".

by

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Submitted to the Department of  
Physics and Astronomy and the  
Faculty of the Graduate School  
of the University of Kansas  
in partial fulfillment of the  
requirements for the degree of  
Master of Arts.

Approved by:



Department of Physics  
and Astronomy.

1923 May 25.

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## The Orbit of the Spectroscopic Binary 2 Monocerotis.

INTRODUCTION - History and description of star.

The spectroscopic binary "2 Monocerotis" was discovered at the Yerkes Observatory in 1914 by Mr. S.B. Barrett. The announcement in Popular Astronomy Vol. 22, page 234, (1914) gave the period as approximately 9.36 days and the range as 120 kilometers per second. The presence of the secondary component was suspected. In 1919 Mr. Barrett had measured twenty-six plates and had established the period as 9.355 days.

Other duties at the Observatory have taken Mr. Barrett from the radial velocity work and the plates were given to the writer for the completion of the orbit.

"2 Monocerotis", R.A. 5h. 54.3m., Decl.  $-9^{\circ} 34'$ , according to the Henry Draper Catalog, is of type A5 and of a visual magnitude 5.10. The spectrum of the primary is very good, with many sharp lines. The secondary component is very weak, showing only at the times of maximum and <sup>and then only</sup> minimum on the good plates. The type could not be determined but seemed to be similar to the primary as the lines of the secondary observable were the iron lines, 4045, 4063, 4071, titanium 4468, 4501, 4549, 4563, 4572, the strontium line 4077, and the magnesium line 4481.

## OBSERVATIONS.

The observations extended over a period of ten and one third years, from 1912 to 1923, distributed as follows:

1912	Fall	2 plates.
1913	Jan	3 plates
	Feb	7 plates (3 on one night)
	Mar	3 plates
	Apr	1 plate
1914	Mar	3 plates
1918	Nov	1 plate
1919		6 plates ( scattered through fall and spring )
1922	Nov	2 plates ( one a 3 prism plate)
	Dec	3 plates
1923	Jan	1 plate.

Table I on page \_\_\_ contains all the observations.

The spectrograms were obtained with the Bruce Spectrograph used with the forty inch telescope at the Yerkes Observatory, Williams Bay, Wisconsin. A complete description of it is given by Director Edwin B. Frost in the *Astrophysical Journal*, Vol. XV, (1902), pp. 1-27. For the most part the spectrograph is used with only one prism but it is so arranged that with about an hours work two more prisms may be inserted and a dispersion *by* the three prisms can be obtained. The camera used is known as the B camera and the plates taken with it are the B series. A prefix 1 or 2 is used with the B to designate one or two prisms and for the three prism plates there is no prefix.

The average dispersion for a three prism plate using the B camera is about ten Angstrom units per millimeter and the one prism is about thirty per millimeter.

## MEASUREMENT and REDUCTION.

The spectrograms were measured with the Gaertner measuring engine of the K. U. Observatory. The engine is especially constructed for the measuring of spectrograms, and consists of a heavy cast iron bed-plate with carefully scrapped guides. The carriage, which holds the spectrum plate, rests on the guides and is moved by a micrometer screw of 0.5 millimeter pitch and a diameter of 15 millimeters. The screw head is graduated in 500 parts. The full revolutions of the screw are read by means of a scale in front of the instrument. The carriage has a range of 80 millimeters. The microscope is adjustable so as to obtain a wide variation in the magnifying power.

The method of measuring a spectrogram is that used at the Yerkes Observatory. The plate is placed upon the carriage, adjusted, and the comparison line ~~of the~~ iron 4045 is placed on the cross-wire when the scale reading is 20,000 and with the violet end of the spectrum to the right. After measures have been made the plate is reversed, scale at 50,000 on the same line, all lines are remeasured.

Four settings are made on each line, the hair-line bisecting the comparison spectrum line at a point about one third the length of the line from the star spectrum. Two settings are made on <sup>the</sup> upper and two on the lower section of the line. The star line is bisected by the hair-line near the center of the spectrum.

The reduction of the one prism spectrograms measures is by the short method of Schlesinger, Publications of the Allegheny Observatory, Vol I, page 9. A table is made for the spectrograms from any one spectrograph. This table was secured from the Yerkes Observatory. The table is constructed from the known wavelength of a star line and from certain comparison lines its distance, for zero velocity is computed. When the plate is measured, the distance of the star line from the comparison lines, one on either side, gives the amount of shift of the line in millimeters. This shift when multiplied by the velocity for a shift of one millimeter gives the velocity of the star. A correction must be made for the varying dispersion of the prisms due to the variation of the temperature at time of observing, from the normal temperature for which the tables are computed. This is done by knowing the normal distance between the two comparison lines and comparing with the distance measured. After the velocity of the plate has been obtained it is necessary to correct for the earth's velocity around the sun in order to secure the radial velocity of the star relative to the sun.

#### PRELIMINARY ELEMENTS.

When the radial velocity of the plates have been found it is necessary to determine the period, the first of the elements of the orbit. Mr. Barrett's 1919 determination of the period was 9.355 days the value I used in plotting the observations. The date January 17. 1913, 15h. 02m. GMT. was taken for the zero phase for it was very near the maximum

velocity. After all the velocities had been plotted, the period was adjusted till the observations fell on the best smooth curve. The final period, assumed definitive as the observations covered a period of ten years, was 9.3553 days.

The remaining elements of the orbit were obtained by the Lehmann-Filhes graphical method. (Page 142, Binary Stars, by Robert G. Aitken). The V-axis or the velocity of the center of mass of the binary is obtained by <sup>measuring</sup> ~~integrating~~ the area above and below the axis and adjusting it till the areas are equal. The velocity can be read *from* the graph.

The velocity at any time is given by the following formula:

$$(1). \quad \frac{d s}{d t} = V + \frac{u a \sin i}{\sqrt{1 - e^2}} \left[ e \cos w + \cos(v + w) \right]$$

where

V = velocity of the center of mass

u = mean daily motion

a = semi-major axis

i = inclination of orbit plane to plane perpendicular line of sight.

e = eccentricity

w = argument of periastron

v = true anomaly

Taking A and B as the magnitudes of the curve-ordinates at the points of maximum and minimum, reckoned from the V-axis, and regarding B as a positive quantity, we have:



$$(2) \quad A = K(1 + e \cos w)$$

$$(3) \quad B = K(1 - e \cos w)$$

$$K = \mu a \sin i / (1 - e^2)$$

and therefore

$$(4) \quad A + B / 2 = K$$

$$(5) \quad A - B / 2 = K e \cos w$$

$$(6) \quad A - B / A + B = e \cos w$$

K is therefore the half-amplitude of the velocity curve.

Let:

a = point on the V-axis of the same phase as A.

b = point of the V-axis of same phase as B.

C = point of aphelion

D = point of perihelion

*See Vel. curve, p. —*

Z<sub>1</sub> = Area of AaC

Z<sub>2</sub> = Area of bBD (regarded as negative in sign)

We then have the formula:

$$(7) \quad e \sin w = \frac{2\sqrt{AB}}{A + B} \frac{Z_2 + Z_1}{Z_2 - Z_1}$$

Equations (6) and (7) determine e and w.

At the time of periastron passage  $v = 0^\circ$  and

hence the equation

$$(8) \quad \frac{d\mathcal{J}}{dt_p} = K(1 + e) \cos w + V.$$

which gives the ordinate corresponding to the point of periastron passage. Two points on the curve will have the

same ordinate, but since  $(v + w)$  equals  $0^\circ$ ,  $180^\circ$ , <sup>or</sup>  $360^\circ$  for

the points A, B, or A<sub>1</sub>, respectively, there is no ambiguity

as to the position of the periastron point.

There is no method except statistically of determining the value of "a" or "i", but the combined value may be obtained by the formula:

$$(9). \quad a \sin i = [4.13833] KP \sqrt{1 - e^2}$$

The values obtained from the velocity curve of 2 Monocerotis are as follows:

$$A = 74.2 \text{ Km.}$$

$$B = 51.0 \text{ Km.}$$

$$V = +21.8 \text{ Km.}$$

$$Z_1 = 5.14$$

$$Z_2 = -5.78$$

$$K = 62.6 \text{ Km.}$$

$$\log \mu = 1.58524$$

which give the following preliminary elements:

$$V = + 21.8$$

$$P = 9.3553 \text{ days}$$

$$e = 0.1937$$

$$K = 62.6 \text{ Km.}$$

$$w = 16^\circ 9'$$

$$T = \text{J.D. } 2419673.41$$

$$a \sin i = 7,900,000 \text{ Km.}$$

#### REPRESENTATION.

To test the elements by comparison with the observations, the radial velocity for each date was computed by the formula:

$$(10) \quad d\xi/dt = V + K e \cos w + K \cos (v + w)$$

The value of "v" was obtained from the "Tables for true Anomaly in Elliptic Orbits" by Schlesinger and Dick, in The Publications of the Allegheny Observatory, Vol. II, page 155. The resulting residuals are in Table I page \_\_\_\_, column O<sup>a</sup> C.

#### LEAST SQUARE SOLUTION.

A least square solution is applied to obtain corrections to the preliminary elements. The solution is that proposed <sup>by Leitman-Filhes and modified</sup> by Schlesinger in the Publications of the Allegheny Observatory, Vol. I, page 33.

The formula (10) for the velocity at any point is differentiated and to facilitate computation is transposed into the following equation:

$$(11) \quad d(d\xi/dt) = \Gamma + \cos u \cdot \kappa + \sin u \cdot \pi + \alpha \sin u \cdot \epsilon + \beta \sin u \cdot \tau$$

which is the equation of condition.

$$\alpha = 0.452 \sin v (2 + e \cos v)$$

$$\beta = \frac{(1 + e \cos v)^2}{(1 + e)^2}$$

$$\Gamma = dV + e \cos w \cdot dK + K \cos w \cdot de - K \sin w \cdot dw$$

$$\kappa = dK$$

$$\pi = -K dw$$

$$\epsilon = -K(2.21/1-e^2) de$$

$$\tau = Kp \sqrt{\frac{1+e}{1-e}} \cdot \frac{d}{(1-e)}$$

The quantities  $\alpha$  and  $\beta$  are tabulated in the Publications

of the Alleghney Observatory, Vol. I, page 38.

The observations are combined into normal places. To do this the weighted means of the phases of the observations (whose phases were about the same) and of the residuals are taken, forming a normal place of weight equal to the combined weights of the observations.

These residuals of the normal places, together with the coefficients of the unknown quantities are substituted into equation (11) to form the equations of condition.

The equations of condition are:

10.	+ 9.00	$\rho$	+ 8.59	$\kappa$	+ 2.70	$\pi$	+ 0.03	$\epsilon$	+ 2.69	$\gamma$	= - 28.0
2).	+ 9.00		+ 7.49		+ 4.99		+ 1.42		+ 4.92		= - 29.6
3).	+ 7.00		- 0.31		+ 6.99		+ 6.28		+ 5.39		= - 30.1
4).	+ 4.00		- 1.56		+ 3.68		+ 3.28		+ 2.48		= + 13.4
5).	+ 6.00		- 3.87		+ 4.58		+ 3.66		+ 2.74		= - 42.0
6).	+ 8.00		- 7.93		+ 1.08		+ 0.37		+ 0.51		= + 24.2
7).	+ 4.00		- 4.00		- 0.05		- 0.01		- 0.22		= + 41.0
8).	+ 9.00		- 6.57		- 6.15		+ 2.24		- 2.95		= +32.2
9).	+13.00		- 4.61	#	-12.35		+ 8.68		- 6.90		= +101.9
10).	+ 5.00		+ 1.35		- 4.82		+ 4.33		- 3.35		= - 10.7
11).	+ 6.00		+ 4.70		- 3.73		+ 2.92		- 3.22		= - 59.8

The solution of the equations of condition is that due to Gauss, i.e. combining them into normal equations. The normal equations are:

$\Gamma$	$K$	$\pi$	$\epsilon$	$\tau$	$\Delta V$
+ 80.00	- 6.12	- 3.08	+ 33.20	+ 2.09	= + 12.5
	+ 39.48	+ 5.09	- 3.92	+ 4.25	= - 197.8
		+ 40.48	- 2.81	+ 27.14	= - 143.5
			+ 22.30	- 0.45	= - 7.9
				+ 19.08	= - 84.7

Solving the above equation the following unknowns are found to be:

$$\Gamma = - 0.85 \quad K = - 5.50 \quad \pi = - 20.29$$

$$\epsilon = - 2.105 \quad \tau = + 25.69$$

which gives the corrections to the elements.

$$dK = - 5.50 \text{ Km.}$$

$$d\omega = + 18^{\circ}57'$$

$$dT = + 0.405 \text{ da.}$$

$$de = + 0.0146$$

$$dV = + 0.44 \text{ Km.}$$

#### DEFINITIVE ELEMENTS.

$$V = + 22.24 \text{ Km.}$$

$$P = 9.3553 \text{ days (assumed)}$$

$$e = 0.2083 \pm 0.0079$$

$$K = 57.1 \pm 2.63 \text{ Km.}$$

$$\omega = 35^{\circ}41' \pm 2^{\circ}66'$$

$$T = \text{J.D. } 2419673.815 \pm 0.064 \text{ da.}$$

$$a \sin i = 7,200,000 \text{ Km.}$$

TABLE I. - THE OBSERVATIONS

No. of Plate	Obs. by:	Meas-ured by:	Date, G. M. T.	* Phase	Primary				Secondary			
					No. of lines	Wt.	Vel.	Resid. O-C.	No. of lines	Wt.	Vel.	Resid. O-C.
1B 3099	B	LV	1912 d. h. m. Sept. 30 21 55	3.089	4	1	-30.4	-3.7	2			+76
3106	L	B	Oct. 4d. 22h.42	7.114	3	1	+34.0	-13.1				
3242	B	LV	1913 Jan. 17 15 02	8.892	9	4	+94.5	- 0.3	4			-52
3258	L	LV	24 15 43	6.552	10	3	+25.2	+0.5				
3263	M	B	Jan. 29 16 15	2.246	15	3	-12.8	+0.4				
3268	L	LV	Feb. 3 16 02	7.207	5	4	+51.7	+0.6	4			-11
3275	B	LV	5 13 31	9.079	4	3	+89.7	-1.6	4			-52
3276	B	LV	5 14 57	9.173	7	3	+82.4	-6.4	5			-58
3277	B	LV	5 16 20	9.266	6	2	+82.5	-3.3	5			-53
3286	M	B	7 14 09	1.778	10	3	-14.0	-14.4	2			+88
3293	B	LV	13 14 44	7.769	8	3	+67.2	-7.4	8			-52
3299	B	LV	24 12 41	0.000	6	3	+80.9	-1.5	6			-48
3308	M	LV	Mar. 5 13 10	9.079	5	2	+80.3	-11.0	3			-65
3313	B	B	10 14 22	4.680	5	1	-13.1	+9.4				
3322	B	B	21 13 18	6.271	5	2	+24.5	+9.8				
3340	L	B	Apr. 15 13 43	3.276	3	1	-23.6	+4.5				
3681	F	LV	1914 Mar. 4 13 10	8.143	3	2	+74.9	-12.6	3			-51
3682	B	B	9 14 00	3.838	1	1	-23.4	+5.6				
3699	F	B	16 14 19	1.498	5	2	+6.7	-4.1				
5420	Wk. B	B	1918 Nov. 11 19 38	0.000	7	1	+83.1	+0.7	4			-46
5437	B	B	1919 Jan. 24 14 18	8.330	7	1	+79.7	-12.4	2			-39

Table I. (cont.)

No. of Plate	Obs. by:	Meas-ured by:	Date, G. M. T.			*Phase	Primary			Secondary			
							No. of lines	Wt.	Vel.	Resid. 0-C	No. of lines	Wt.	Vel.
5452	B	LV	Feb. 7	14	20	3.650	5	3	-17.4	+11.8	4	+107	
5468	B	LV	Mar. 7	12	52	3.463	5	3	-23.0	+5.9	4	+90	
5624	B, Pr.	B	Nov. 3	20	36	1.591	6	2	+18.0	+10.8			
5640	B, Pr.	B		21	28	0.936	5	2	+27.3	-9.3			
5646	Pr, B	LV	Dec. 15	19	33	6.084	8	4	+19.0	+10.4			
			1922										
6652	999999	LV	Nov. 6	20	41	6.178	9	4	+21.4	+9.8			
6674		LV	Dec. 11	17	40	3.463	11	3	-27.0	+1.9	7	+97	
6681		LV		18	19	1.219	8	2	+37.5	+14.5			
6691		LV	1923	22	19	23	5.242	8	3	-13.0	+0.1		
6707		LV	Jan. 15	16	56	1.030	8	3	+18.4	-13.5			
B970		LV	1922										
			Nov. 24	20	56	5.429	4	5	-4.5	+4.5	4	+59	

\* Based on definitive period and time of Periastron passage.

Observers listed in Table I.

B = S. B. Barrett  
 F = Edwin B. Frost  
 L = O. J. Lee  
 Lv = C. T. Elvey  
 M = A. J. Monck  
 Pr = J. Paraskeropoulos  
     = Otto Struve  
 Wk = Miss Wickham

Table II. Table of Normal Places.

No.:	Phase :	Wt.:	Obs. Vel. :	O & C
1	: 95.8	: 9	: + 90.0	: + 2.2
2	: 98.8	: 9	: + 82.2	: + 0.2
3	: 11.0	: 7	: + 26.3	: - 2.1
4	: 16.2	: 4	: + 12.4	: + 6.1
5	: 21.2	: 6	: - 14.0	: - 5.0
6	: 35.9	: 8	: - 25.6	: - 0.4
7	: 39.2	: 4	: - 19.0	: + 5.5
8	: 56.1	: 9	: - 8.7	: - 4.1
9	: 66.5	: 13	: + 21.9	: + 2.8
10	: 76.5	: 5	: + 48.2	: - 0.6
11	: 85.0	: 6	: + 72.5	: - 2.7





SUMMARY OF MEASURES

Object: Type:  
 R.A.: 2 Monocerotis Decl.: 9°34' A5  
 5 h. 54m.

Plate: 1

Number: 1B 3099  
 Date: 1912 Sept. 30  
 G.M.T.: 21h. 55m.

Observed by: B  
 Measured by: LV.  
 Weight of plate: 1

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4250	- 36.85	+ 40.72			
4481	- 47.14				
4549	- 144.50	+ 88.20			
4563	- 46.70				

Weighted Mean  
 Reduction to sun - 55.04 + 51.59  
 + 24.66 + 24.66  
 Radial Velocity  
 - 30.38 + 76.25

Plate: 3

Number: 1B 3242  
 Date: 1913 Jan. 17  
 G.M.T.: 15h. 02m.

Observed by:  
 Measured by: B.  
 Weight of plate: LV. 4

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 113.70	- 28.56	4163	+ 104.30	- 41.12
4063	+ 103.50		4202	+ 106.80	
4077	+ 107.45		4468	+ 95.75	- 32.00
4132	+ 116.20		4481	+ 113.25	-
			4549	+ 96.80	- 57.87

Weighted Mean  
 Reduction to Sun + 106.53 - 39.89  
 - 12.08 - 12.08  
 Radial Velocity  
 + 94.45 - 51.97

SUMMARY OF MEASURES

Object: 2 Monocerotis Type: A5  
 R.A.: 5h. 54m. Decl.: -9° 34'

Plate: 4

Number: 1B 3258  
 Date: 1913 Jan. 24  
 G.M.T.: 15h. 43m.

Observed by: L.  
 Measured by: Lv.  
 Weight of plate: 3

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 44.80	:			
4063	+ 34.84	:	4501	+ 32.11	:
4077	+ 46.37	:	4549	+ 28.62	:
4132	+ 55.60	:	4572	+ 37.91	:
4202	+ 6.50	:			
4468	+ 44.32	:			
4481	+ 48.31	:			

Weighted Mean + 39.94  
 Reduction to sun - 14.79

Radial Velocity + 25.15

Plate: 6

Number: 1B 3268  
 Date: 1913 Feb. 3  
 G.M.T.: 16h. 02m.

Observed by: L  
 Measured by: Lv.  
 Weight of plate: 4

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 138.16	+ 10.78	4202	+ 137.70	- 1.44
4063	+ 145.10	+ 11.80	4481	+ 133.40	
4071	+ 75.20	+ 5.73			

Weighted Mean + 69.95 + 6.72  
 Reduction to Sun - 18.21 - 18.21

Radial Velocity + 51.74 - 11.49

SUMMARY OF MEASURES

Object: 2 Monocerotis Type: A5  
 R.A.: 5h. 54m. Decl.: -9° 34'

Plate: 7

Number: 1B 3275 Observed by: B.  
 Date: 1913 Feb. 5 Measured by: Lv.  
 G.M.T.: 13h. 31m. Weight of plate: 3

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 216.30	- 28.85			
4063	+ 215.80	- 35.55			
4077	+ 209.50	- 15.69			
4481	+ 224.90	- 53.19			

Weighted Mean + 108.31 - 33.32  
 Reduction to sun - 18.57 - 18.57

Radial Velocity + 89.74 - 51.89

Plate: 8

Number: 1B 3276 Observed by: B.  
 Date: 1913 Feb. 5 Measured by: Lv.  
 G.M.T.: 14h. 57m. Weight of plate: 3

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 210.00	- 28.28	4250	+ 88.44	- 40.52
4063	+ 332.70		4501	+ 83.95	- 51.20
4077	+ 221.50		4549	+ 184.39	- 30.20
4144	+ 92.00	- 27.14			

Weighted Mean + 101.06 - 39.41  
 Reduction to Sun - 18.71 - 18.71

Radial Velocity + 82.37 - 58.12

SUMMARY OF MEASURES

Object: 2 Monocerotis  
 R.A.: 5h. 54m. Decl.: -9° 34' Type: A5

Plate: 9

Number: 1B 3277 Observed by: B.  
 Date: 1913 Feb. 5 Measured by: Lv.  
 G.M.T.: 16h, 20m. Weight of plate: 2

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 337.35	- 22.69	4171	+ 168.40	- 44.85
4063	+ 201.30	-	4481	+ 200.60	+ 13.64
4077	+ 226.40	+ 21.02			
4150	+ 183.20	- 49.45			

Weighted Mean + 101.33 - 33.70  
 Reduction to sun - 18.86 - 18.86  
 Radial Velocity + 82.47 - 52.56

Plate: 11

Number: 1B 3293 Observed by: B.  
 Date: 1913 Feb. 13 Measured by: Lv.  
 G.M.T.: 14h. 44m. Weight of plate: 3

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 90.14	- 7.00	4468	+ 100.02	- 25.80
4063	+ 81.45	- 8.38	4481	+ 177.56	- 29.80
4071	+ 101.20	- 12.16	4549	+ 167.88	- 37.70
4077	+ 82.80	+ 2.96	4563	+ 79.80	- 28.90

Weighted Mean + 88.08 - 21.39  
 Reduction to Sun - 20.89 - 20.89  
 Radial Velocity + 67.19 - 52.28

SUMMARY OF MEASURES

Object: 2 Monocerotis  
 R.A.: 5h. 54m. Decl.: 9° 34' Type: A5

Plate: 12

Number: 1B 3299 Observed by: B.  
 Date: 1913 Feb 24 Measured by: Lv.  
 G.M.T.: 12h. 41m. Weight of plate: 3

Wave	Wt. x Velocity	Wave	Wt. x Velocity
Length: Primary: Secondary	Length: Primary: Secondary	Length: Primary: Secondary	Length: Primary: Secondary
4045	+ 217.60: - 22.95	4501	+ 179.20: - 38.14
4071	+ 207.40: - 29.35	4563	+ 188.44: - 21.60
4077	+ 223.60: - 8.06		
4481	+ 231.00: - 31.46		

Weighted Mean + 103.94 - 25.29  
 Reduction to sun - 23.04 - 23.04

Radial Velocity + 80.90 - 48.33

Plate: 13

Number: 1B 3308 Observed by: M.  
 Date: 1913 Mar 5 Measured by: Lv.  
 G.M.T.: 13h. 10m. Weight of plate: 2

Wave	Wt. x Velocity	Wave	Wt. x Velocity
Length: Primary: Secondary	Length: Primary: Secondary	Length: Primary: Secondary	Length: Primary: Secondary
4045	+ 108.40:	4572	+ 112.35: - 26.95
4071	+ 101.55:		
4481	+ 213.10: - 53.80		
4549	+ 302.40: - 39.85		

Weighted Mean + 104.73 - 40.20  
 Reduction to Sun - 24.47 - 24.47

Radial Velocity + 80.26 - 64.67

SUMMARY OF MEASURES

Object: 2 Monocerotis                      Type: A5  
 R.A.: 5h. 54m.                      Decl.: -9° 34'

Plate: 17

Number: 1B 3681                      Observed by: F.  
 Date: 1914 Mar 4                      Measured by: Lv.  
 G.M.T.: 13h. 10m.                      Weight of plate: 2

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 198.62	- 15.96	:	:	:
:	:	:	:	:	:
4063	+ 97.25	- 27.85	:	:	:
:	:	:	:	:	:
4572	+ 199.80	- 35.15	:	:	:
:	:	:	:	:	:
:	:	:	:	:	:
:	:	:	:	:	:

Weighted Mean                      + 99.13   - 26.52  
 Reduction to sun                      - 24.20   - 24.20

Radial Velocity                      + 74.93   # - 50.52

Plate: 22

Number: 1B5452                      Observed by: P.  
 Date: 1919 Feb 7                      Measured by: Lv.  
 G.M.T.: 14h. 20m.                      Weight of plate: 3

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 120.6	0.00	:	:	:
:	:	:	:	:	:
4063	+ 127.0	+ 5.7	:	:	:
4071	+ :	+ 3.2	:	:	:
4077	+ 128.3	0.0	:	:	:
:	:	:	:	:	:
4563	+ 129.7	+ 3.2	:	:	:
:	:	:	:	:	:

Weighted Mean                      + 126.4   + 1.7  
 Reduction to Sun                      - 19.09   - 19.09

Radial Velocity                      + 107.3   - 17.4

SUMMARY OF MEASURES

Object: 2 Monocerotis Type: A5  
 R.A.: 5h, 54m. Decl.: -9° 34'

Plate: 23

Number: 1B 5468 Observed by: B  
 Date: 1919 Mar 7 Measured by: Lv.  
 G.M.T.: 12h. 52m. Weight of plate: 3

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 11.76	+ 113.20	4572	+ 8.85	+ 122.20
4071	+ 5.74	+ 122.10			
4163	+ 7.20				
4549	- 20.76	+ 100.90			

Weighted Mean + 1.42 + 114.60  
 Reduction to sun - 24.47 - 24.47

Radial Velocity - 23.05 + 90.13

Plate: 26.

Number: 1B 5646 Observed by: Pr.  
 Date: 1919 Dec 15 Measured by: Lv.  
 G.M.T.: 19h. 33m. Weight of plate: 4

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 17.79		4163	+ 20.80	
4063	+ 19.34		4443	+ 13.11	
4071	+ 20.90		4481	+ 17.42	
4077	+ 19.86		4549	+ 6.02	

Weighted Mean + 16.90  
 Reduction to Sun + 2.11

Radial Velocity + 19.01



SUMMARY OF MEASURES

Object: 2 Monocerotis      Type: A5  
 R.A.: 5h. 54m.      Decl.: -9° 34'

Plate: 27

Number: 1B 6652      Observed by:  $\sigma$   
 Date: 1922 Nov 6      Measured by: Lv.  
 G.M.T.: 20h. 41m.      Weight of plate: 4

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 4.76		4481	+ 2.57	
4063	+ 4.27		4549	+ 3.97	
4077	+ 4.18		4572	+ 2.11	
			4501	+ 5.22	
			4202	+ 3.84	
4163	+ 4.82				

Weighted Mean      + 3.97  
 Reduction to sun      + 17.41

Radial Velocity      + 21.38

Plate: 28

Number: 1B 6674      Observed by:  $\sigma$   
 Date: 1922 Dec 11      Measured by: Lv.  
 G.M.T.: 17h. 40 m.      Weight of plate: 3

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	-52.60		4481	- 42.00	
4071	- 31.50	+ 113.50	4501	- 24.28	
4077	- 33.70	+ 100.20	4549	-107.16	+ 71.00
4144	- 79.74		4563	- 43.80	+ 84.20
4326	- 65.20	+ 84.35	4572	- 53.48	+ 97.30
4404	- 55.10	+ 51.55			

Weighted Mean      - 30.98      + 92.65  
 Reduction to Sun      + 3.97      + 3.97

Radial Velocity      - 27.01      + 96.60

SUMMARY OF MEASURES

Object: 2 Monocerotis  
 R.A.: 5h. 54m. Decl.: <sup>Type: A5</sup> -9° 34'

Plate: 29

Number: 1B 6681 Observed by:  $\sigma$   
 Date: 1922 Dec 18 Measured by: Lv.  
 G.M.T.: 19h. 54m. Weight of plate: 2

Wave	Wt. x Velocity	Wave	Wt. x Velocity
Length: Primary: Secondary		Length: Primary: Secondary	
4045	+ 38.40	4202	+ 85.24
4063	+ 36.10	4481	+ 12.07
4071	+ 42.80	4549	+ 15.15
4077	+ 33.27	4383	+ 29.52

Weighted Mean + 36.82  
 Reduction to sun + 0.64  
 Radial Velocity + 37.46 Km/sec.

Plate: 30

Number: 1B 6691 Observed by:  $\sigma$   
 Date: 1922 Dec 22 Measured by: Lv.  
 G.M.T.: 19h. 23m. Weight of plate: 3

Wave	Wt. x Velocity	Wave	Wt. x Velocity
Length: Primary: Secondary		Length: Primary: Secondary	
4045	- 13.30	4481	- 20.04
4063	- 6.96	4549	- 32.76
4077	- 11.66	4563	- 11.52
4202	- 3.04	4572	- 7.59

Weighted Mean - 11.88  
 Reduction to Sun - 1.10  
 Radial Velocity - 12.98 Km/sec.

SUMMARY OF MEASURES

Object: 2 Monocerotis Type: A5  
 R.A.: 5h. 54m. Decl.: -9° 34'

Plate: 31

Number: 1B 6707  
 Date: 1923 Jan 15  
 G.M.T.: 16h. 56m.

Observed by:  $\sigma$   
 Measured by:  
 Weight of plate: Lv. 3

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4045	+ 89.60		4481	+ 27.32	
4063	+ 39.38		4549	+ 27.40	
4077	+ 30.86		4563	+ 37.92	
4202	+ 45.50		4572	+ 28.22	

Weighted Mean  
 Reduction to sun + 29.65  
~~11.25~~

Radial Velocity + 18.40 Km/ sec.

Plate: 32

Number: B 970  
 Date: 1922 Nov 24  
 G.M.T.: 20h. 56m.

Observed by:  $\sigma$   
 Measured by:  
 Weight of plate: Lv. 5

Wave	Wt. x Velocity		Wave	Wt. x Velocity	
Length:	Primary:	Secondary:	Length:	Primary:	Secondary:
4395	- 15.63	+ 52.98			
4468	- 14.96	+ 45.70			
4481	- 17.53	+ 45.82			
4501	- 13.26	+ 52.02			

Weighted Mean  
 Reduction to Sun - 15.34 + 49.13  
~~+ 10.87 + 10.87~~

Radial Velocity - 4.47 + 60.00  
 Km/sec.