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Hon. W. J. Roche, *Minister*. W. W. Cory, C.M.G., *Deputy Minister*.

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Orbit of 88 *d* Tauri

BY

W. E. HARPER, M. A.

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ORBIT OF 88 *d* TAURI.

BY W. E. HARPER, M.A.

This star whose right ascension is four hours thirty minutes, declination north nine degrees fifty seven minutes, photographic magnitude 4.5 was announced as a spectroscopic binary by Moore in L. O. B. 4, 162, 1907. A second announcement as to its binary nature was made last year from the Mt. Wilson Observatory. Possibly as it was given in their list by the number 88 they had overlooked the previous announcement of the star under the designation *d* Tauri by the Lick astronomers.

The early observations of Moore, five in number, have proved of great value in determining the period. Between the first observation at Lick and the last one here an interval of about 750 periods has elapsed, so that it is possible to arrive at a value for the period which must be very near the true value. The period 3.5711 days was considered the best until the observations were grouped and a solution made, when it was seen that by increasing the period to 3.5712 days (an increase of about nine seconds) a much better agreement with the curve would be secured. This latter value, then, was the period adopted.

The star is of the hydrogen type being designated A_2 in the Harvard classification, though it approaches somewhat nearer than that to F-type as, with proper exposure, a number of metallic lines in the spectrum are seen. The single-prism camera was used throughout, and of the 28 plates secured 8 were made on Seed 30 emulsion, 4 on Seed 23 and 16 on the regular Seed 27. The lines of the spectrum should be fairly well measurable if the plates secured were of good quality, but the continued poor observing weather of the past nine months or so has rendered acceptable almost any kind of plate. As a result the velocities obtained have a larger probable error than otherwise would be the case, but the fairly high range in velocity compensates for this to a great extent and permits of a fairly accurate determination of the orbital elements. Some lines due to the spectrum of the second component are faintly visible, the finer grained Seed 23 plates being more suitable to record these. Further mention will be made of this later.

Besides the magnesium line and the lines due to hydrogen there were visible, as previously mentioned, metallic lines which were quite frequently measurable. The accompanying table gives the lines most commonly measured; among these it will be noted are many lines due to iron. It has been customary to obtain corrected values of the wave-lengths by considering the residuals for each line from the mean of the plate and equating their sum to zero, but owing to the poor quality of the plates this procedure has not been carried out in this case. At best, only three lines, λ 4352, λ 4308 and λ 4233 would seem to be in need of correction so that the revised velocities would not differ materially from those herein given.

LINES USED IN *d* TAURI.

Line.	Element.	Average Algebraic Residual.	Times measured.	Line.	Element.	Average Algebraic Residual.	Times measured.
4,584·018	Fe	+ 4·2	6	4,271·760	Fe	− 1·4	16
4,549·766	Fe-Ti	+ 0·8	22	4,236·107	Fe	− 3·6	13
4,481·400	Mg.	− 1·1	28	4,233·328	Fe	− 6·1	17
4,404·927	Fe	+ 2·4	8	4,143·928	Fe	+ 2·2	8
4,352·006	Cr-Mg	+ 5·5	15	4,071·901	Fe	+ 4·4	9
4,340·634	H	− 1·2	22	4,063·756	Fe	+ 3·2	15
4,325·829	Fe	− 0·6	10	4,045·975	Fe	− 0·2	22
4,308·081	Fe	+ 6·2	9	4,005·597	Fe	+ 1·7	18

The observations of this star obtained at other observatories with their residuals according to the elements obtained here are given. Then follow the data of our own observations and the measures in a combined table.

MEASURES OF *d* TAURI AT OTHER OBSERVATORIES.

Observatory.	Date.	Julian Day.	Phase.	Velocity.	Resid. O-C.
Lick	1905, Nov. 18	2,417,168·888	·717	+ 51·7	+ 3·1
"	1906, Oct. 1	7,485·966	3·529	+ 103·9	− 0·5
"	1907, Aug. 25	7,813·993	3·006	+ 65·8	+ 0·3
"	" Oct. 6	7,855·952	2·111	− 34·3	− 6·1
"	" Oct. 13	7,862·895	1·911	− 44·4	− 8·2
Mt. Wilson	1911, Oct. 9	9,319·909	1·876	− 43·	− 6·
"	" Nov. 3	9,344·939	1·907	− 40·	− 3·
"	1912, Jan. 5	9,407·829	·516	+ 71·	− 2·

TABLE OF OBSERVATIONS OF *d* TAURI.

Plate.	Ob.	Date.	Ex.	Julian Date.	Phase.	Component I.			Component II.		
						Vel.	Wt.	O-C.	Vel.	Wt.	O-C.
		1908	m.								
1,965	C	Nov. 13.......	43	2,418,259·682	2·295	− 19·7	7	− 4·7			
2,014	H	Dec. 9.........	60	8,285·638	3·253	+ 86·9	4	− 4·1			
		1912									
4,834	P	Feb. 12........	45	9,445·602	2·577	+ 21·1	6	+ 7·7			
4,850	H	Feb. 20........	62	9,453·612	3·444	+ 96·7	5	− 5·9	− 83·3	1	
4,854	H	Feb. 23........	60	9,456·639	2·900	+ 45·8	5	− 7·4			
4,856	H	Feb. 27........	75	9,460·629	3·319	+ 97·4	4	+ 1·2			
4,859	C	Feb. 28........	50	9,461·597	·716	+ 44·5	5	− 4·0			
4,870	H	Mar. 5	60	9,467·603	3·151	+ 80·3	7	− 2·0			
4,881	H	Mar. 12.......	65	9,474·563	2·968	+ 68·0	5	+ 6·0			
4,884	C	Mar. 13.......	55	9,475·506	·340	+ 95·9	6	+ 6·3			
5,171	H	Aug. 27.......	40	9,642·866	3·424	+109·7	5	+ 7·3			
5,178	H	Aug. 29.......	55	9,644·857	1·844	− 41·8	4	− 4·4			
5,219	P[1]	Oct. 4.........	75	9,680·834	2·109	− 29·1	8	+ 1·9	+180·6	1	
5,237	P[1]	Oct. 7.........	75	9,683·846	1·550	− 35·1	7	− 2·4	+193·5	1	
5,248	P	Oct. 16........	75	9,692·926	3·488	+108·0	4	+ 4·0			
5,252	H	Oct. 17........	64	9,693·911	·902	+ 26·6	5	+ 2·6			
5,266	P	Oct. 30........	40	9,706·739	3·015	+ 70·6	7	+ 3·6			
5,291	P[1]	Dec. 20........	57	9,757·652	·361	+ 93·1	7	+ 5·4			
5,300	P	Dec. 21........	30	9,758·669	1·378	− 13·3	2	+ 7·7			
		1913									
5,302	H	Jan. 1........	110	9,769·686	1·681	− 41·0	5	− 4·4			
5,307	H	Jan. 8........	56	9,776·610	1·463	− 21·2	7	+ 7·4			
5,313	P	Jan. 12........	70	9,780·650	1·932	− 30·0	7	+ 5·6	+170·1	1	
5,320	P	Jan. 22........	65	9,790·672	1·240	− 10·6	6	+ 1·4			
5,329	H	Jan. 28........	54	9,796·642	·067	+ 98·9	6	− 4·7	− 82·1	1	
5,348	H	Feb. 6........	90	9,805·593	1·876	− 41·5	9	− 4·5	+193·0	3	
5,359	P	Feb. 12........	60	9,811·556	·697	+ 42·0	5	− 8·0			
5,369	P[1]	Feb. 17........	65	9,816·522	2·091	− 31·1	5	− 2·0	+143·8	½	
5,433	H	Mar. 12.......	75	9,839·536	·107	+108·1	4	+ 5·0			

The detailed measures of the 28 plates follow. In a few cases the plates were remeasured and the mean of the results as given in the summary of measures was accepted. The weight assigned a plate was based primarily on the number and weight of the lines measured. The plates were weighted independently upon the basis of the quality of the plate but only in one case was it found necessary to change the weights assigned. The exception was plate number 5252. When this plate was made the temperature control was poor and its weight was reduced from 9 to 5.

MEASURES OF *d* TAURI.

λ	1,965		2,014		4,834		4,850		4,854		4,856		4,859	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4,861											+ 132·2	¼	+ 86·8	¼
4,584	− 35·1	½	+ 87·0	½			+ 119·0	¼					100·5	¼
4,549	31·4	¾	99·0	½	+ 49·6	1	131·8	½			130·2	½	64·2	¼
4,534	26·4	1	90·5	½									54·2	¼
4,522	19·1	1												
4,508							144·0	¼						
4,481	25·1	1	91·4	½	52·1	1	123·8	1	+ 86·0	½	124·2	½	99·5	¾
4,404											120·0	½	46·6	¼
4,352					51·2	¾	148·5	1	61·5	½	122·7	¼	56·2	¼
4,340	30·7	½			47·9	½	138·8	½	71·2	½	131·4	½	68·3	¼
4,325													84·2	¼
4,271	25·0	¾	104·8	¼			125·5	½						
4,236							109·8	1	71·4	½				
4,233	24·8	½	97·0	¼			150·0	1						
4,143							134·0	½						
4,071					55·5	¼			70·2	¾			71·2	¼
4,063	30·0	1	78·5	½	51·0	1	135·2	1			119·3	¼	55·6	½
4,045	29·6	1	+ 100·2	½	50·0	1	121·2	1			131·3	½		
4,005	− 29·0	1			+ 48·0	1	+ 106·8	1	+ 88·7	1	+ 131·0	½	+ 73·0	¼
Weighted mean	− 27·33		+ 92·50		+ 50·31		+129·06		+ 76·38		+127·36		+ 74·45	
V_a	+ 7·82		− 5·41		− 28·49		− 29·23		− 29·37		− 29·42		− 29·41	
V_d	+ ·13		+ ·09		− ·17		− ·22		− ·28		− ·28		− ·23	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·23	
Radial Velocity	− 19·7		+ 86·9		+ 21·4		+ 99·3		+ 46·4		+ 97·4		+ 44·5	

MEASURES OF *d* TAURI.

λ	4,870		4,881		4,884		5,171		5,178		5,219		5,237	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4,584					+ 122·6	½								
4,549	+ 96·7	1	+ 102·5	¾	107·8	¼	+ 77·9	1	− 54·3	¾	− 49·0	1	− 60·5	½
4,522							76·7	1	70·0	1				
4,481	106·5	1	99·5	1	140·4	½	87·6	½	85·2	½	67·0	1	58·2	1
4,468					129·4	½								
4,404	111·6	½			118·5	¾	85·6	1			58·3	1		
4,352			83·2	½										
4,340	106·5	1	79·1	¾	128·5	½	100·5	½			41·9	½	57·2	½
4,325			93·0	½							53·7	1	64·3	1
4,308									77·0	½	48·9	1		
4,290											55·8	1	62·8	1
4,271							72·6	½			45·8	1	55·9	1
4,260			103·6	½									58·6	1
4,236	118·4	½					82·6	½			53·5	½	45·3	½
4,233					135·4	½			75·0	½	42·1	1	46·1	1
4,143					116·6	¾								
4,101	105·0	½												
4,071											56·4	½		
4,063	111·2	½	113·7	½	107·6	½			− 70·8	¾			49·2	1
4,045	110·5	½	+ 100·0	1	129·6	¾	+ 71·4	½			− 60·2	½	− 63·5	1
4,005	127·5	½			126·0	1								
3,933	+ 126·0	½			+ 128·5	½								
Weighted mean	+109·97		+ 97·00		+124·70		+ 81·37		− 70·60		− 52·71		− 57·85	
V_s	− 29·16		− 28·46		− 28·36		+ 28·84		+ 28·87		+ 23·86		+ 22·98	
V_d	− ·26		− ·24		− ·15		+ ·19		+ ·19		+ ·04		·00	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity.	+ 80·3		+ 68·0		+ 95·9		+110·1		− 41·8		− 29·1		− 35·1	

MEASURES OF *d* TAURI.

λ	5,248 Vel.	5,248 Wt.	5,252 Vel.	5,252 Wt.	5,266 Vel.	5,266 Wt.	5,291 Vel.	5,291 Wt.	5,300 Vel.	5,300 Wt.	5,302 Vel.	5,302 Wt.	5,307 Vel.	5,307 Wt.
4,584	...	...	+ 1·3	½	...	...	...	...	...	...	...	...	...	...
4,549	...	...	− 1·2	1	+ 47·2	1	+ 124·6	¼	...	...	− 37·3	½	+ 8·6	½
4,522	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4,481	+ 87·8	1	+ 17·8	1	50·8	1	108·2	¾	− 0·6	¼	17·4	½	+ 0·6	¾
4,404	87·5	1	+ 6·4	1	...	...	...	...	...	...	...	...	...	...
4,352	...	...	− 3·7	1	44·0	1	89·4	½	− 2·9	¾	...	...	+ 11·2	½
4,340	84·5	½	+ 10·7	1	...	...	84·2	¾	...	...	12·0	½	− 12·5	½
4,325	...	...	+ 7·3	1	...	...	101·2	¼	+ 1·3	¼	...	...	...	...
4,308	...	...	+ 5·4	½	42·9	1	...	...	− 1·7	¼	...	...	− 2·6	½
4,290	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4,271	...	...	− 4·0	1	64·9	1	114·0	½	...	...	...	...	+ 2·2	1
4,260	...	...	...	...	64·4	1	122·0	1	...	...	...	...	+ 12·1	½
4,236	91·0	1	+ 5·4	1	65·6	1	...	...	...	...	8·5	½	− 22·7	1
4,233	...	...	+ 15·0	1	...	...	...	...	...	...	...	...	+ 3·3	1
4,202	...	...	...	...	...	...	119·5	½	...	...	...	...	...	...
4,143	...	...	...	...	65·7	1	95·2	1	...	...	34·8	½	...	...
4,101	...	...	...	...	...	...	...	...	...	...	19·6	½	+ 6·7	¾
4,071	...	...	+ 6·9	½	50·0	1	...	...	...	...	30·0	¾	...	...
4,063	...	...	...	...	...	...	...	...	...	...	39·6	¾	− 19·2	½
4,045	86·2	½	+ 7·0	1	58·0	1	109·0	1	...	...	− 20·7	½	− 11·9	1
4,005	+ 81·2	½	+ 1·3	1	+ 50·0	1	95·0	1	...	...	...	...	...	...
3,933	...	...	...	...	...	...	+ 102·0	½	...	...	...	...	...	...
Weighted mean	+ 88·54		+ 7·50		+ 54·86		+104·30		− 1·62		− 24·15		− 1·58	
V_a	+ 19·92		+ 19·58		+ 14·36		− 10·89		− 11·35		− 16·41		− 19·27	
V_d	− ·15		− ·15		+ ·10		± ·00		− ·02		− ·12		− ·02	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity.	+108·0		+ 26·6		+ 69·0		+ 93·1		− 13·3		− 41·0		− 21·2	

MEASURES OF *d* TAURI.

λ	5,313		5,320		5,329		5,348		5,359		5,369		5,433	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4,584	− 34·6	½			+ 143·5	½	− 17·9	½						
4,558							13·4	¼						
4,549	− 13·3	½	+ 4·7	1	122·0	½	21·3	¾	+ 70·7	½			+ 125·4	¼
4,481	+ 4·7	1	19·4	1	133·4	1½	9·3	1	79·0	¾	− 7·1	½	132·6	¼
4,443							5·2	½						
4,415									71·2	½				
4,404			10·0	½										
4,352			8·3	1	124·2	½	35·7	½	72·9	½			143·5	¼
4,340	− 6·1	½			119·8	½	0·4	½	62·0	½	− 5·3	¼	135·5	½
4,325	− 9·7	½					7·0	¾			− 0·2	½		
4,320	− 13·6	1												
4,308			5·4	½	109·2	½	25·2	½						
4,294	− 2·0	¼					17·7	½						
4,290			13·9	1										
4,271	− 18·8	½	24·5	½	124·5	¼	20·4	¾	67·4	½	+ 8·2	1		
4,260														
4,236	− 4·3	½			128·2	¼					− 23·2	½	143·0	½
4,233			9·5	½	141·0	½	5·2	¾			− 7·7	½	136·0	½
4,143	− 48·0	½			122·6	½	6·2	½	63·4	½			142·4	½
4,101											− 10·6	¼	140·8	½
4,071	− 21·8	½							63·7	¼				
4,063			28·9	1			16·4	½						
4,045	− 8·9	1	+ 12·7	1	125·6	½	13·0	1	83·6	½	+ 6·7	1	+ 127·0	¼
4,005	− 21·0	½			+ 118·6	½	− 17·4	¾	68·5	½	− 11·4	¼		
Weighted mean	− 13·80		+ 14·08		+ 127·15		− 13·40		+ 70·99		− 2·27		+ 137·10	
V_a	− 20·81		− 24·15		− 27·78		− 27·69		− 28·57		− 29·08		− 28·52	
V_d	− ·13		− ·21		− ·17		− ·13		− ·11		− ·09		− ·19	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity..	− 35·0		− 10·6		+ 98·9		− 41·5		+ 42·0		− 31·7		+ 108·1	

Using the adopted value of the period, the observations of the main component were combined into ten groups as follows:

NORMAL PLACES.

	Mean Phase.	Mean Vel.	Weight.	Residual O-C	Equation-Ephemeris.
1	3·420	+102·98	1·8	+ 1·35	+ ·07
2	·234	+ 97·95	2·3	+ ·57	+ ·09
3	·771	+ 37·70	1·5	− 3·37	+ ·07
4	1·362	− 15·91	1·5	+ 6·04	− ·12
5	1·604	− 37·56	1·2	− 2·97	− ·03
6	1·889	− 37·53	2·0	− ·97	− ·00
7	2·170	− 26·31	2·0	− 1·66	− ·12
8	2·577	+ 21·10	0·6	+ 7·51	− ·14
9	2·934	+ 56·90	1·0	− ·92	+ ·08
10	3·121	+ 78·00	1·8	− 1·22	+ ·14

A plot of these showed that the eccentricity was very small. Where this is the case the value of ω cannot be determined with any great degree of accuracy. Several trials were made with ω in different quadrants and corresponding values for T and a value for ω about 0° seemed to be best, judging by the sum of the squares of the residuals. Were it not for the third and eighth normal places, particularly the former on account of its greater weight, a value of the eccentricity practically zero would suit the observations almost as well as any. Where both spectra are present, as in this case, the tendency of the measured velocities around the γ-line is to deviate from what should be their true value towards this line, and consequently the velocities of these two groups are somewhat in error. A slight error in the determination of the elements will result, particularly in the case of e which will have a somewhat larger value than its true one, but, on the whole, the tendency will be for the errors in each group to neutralize one another.

The values adopted as preliminary were the following.

$$P = 3{\cdot}5712 \text{ days}$$
$$e = {\cdot}02$$
$$\omega = 0° \text{ (fixed)}$$
$$K = 71 \text{ km.}$$
$$\gamma = +29{\cdot}58 \text{ km}$$
$$T = \text{J. D. } 2417168{\cdot}171$$

The value of ω was considered fixed; otherwise the solution would become indeterminate through the coefficients of ω and T being nearly equal owing to the small value of e.

With these elements were computed, according to the differential formula of Lehman-Filhés*, observation equations connecting the four elements γ, K, e and ω with the residuals. For the sake of homogeneity the following substitutions were made.

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

OBSERVATION EQUATIONS FOR *d* TAURI.

	x	y	z	u	
1	1·000	+ ·982	+ ·848	− ·284	− 3·66 = 0
2	1·000	+ ·929	+ ·651	+ ·431	− 2·38 = 0
3	1·000	+ ·193	− ·944	+ ·992	+ 5·61 = 0
4	1·000	− ·733	+ ·141	+ ·638	− 6·57 = 0
5	1·000	− ·933	+ ·820	+ ·297	+ ·86 = 0
6	1·000	− ·965	+ ·941	− ·166	− 1·40 = 0
7	1·000	− ·775	+ ·271	− ·587	+ ·84 = 0
8	1·000	− ·197	− ·903	− ·968	− 5·48 = 0
9	1·000	+ ·421	− ·686	+ ·930	+ 2·56 = 0
10	1·000	+ ·701	− ·080	− ·752	+ 1·35 = 0

*Astronomiche Nachrichten 3242.

These when transformed into normal equations were as follows:

$$15\cdot700x + \cdot060y + 3\cdot854z - 1\cdot090u - 11\cdot888 = 0$$
$$9\cdot776y - \cdot976z - \cdot325u + 1\cdot163 = 0$$
$$7\cdot333z - \cdot125u - 18\cdot792 = 0$$
$$5\cdot954u + \cdot332 = 0$$

from which the following corrections were obtained.

$$\delta\gamma = +\cdot14 \text{ km.}$$
$$\delta K = +\cdot13 \text{ km.}$$
$$\delta e = +\cdot035$$
$$\delta T = \pm\cdot000$$

The sum of the squares of the residuals for the normal places was reduced from 182·8 to 130·4 and one solution was found to be sufficient. The corrected values of the elements, with their probable errors follow:—

$$P = 3\cdot5712 \text{ days}$$
$$e = \cdot055 \pm \cdot019$$
$$\omega = 0°$$
$$K = 71\cdot13 \text{ km.} \pm 1\cdot11 \text{ km.}$$
$$\gamma = +29\cdot72 \text{ km.} \pm 0\cdot94 \text{ km.}$$
$$A = 75\cdot04 \text{ km.}$$
$$B = 67\cdot22 \text{ km.}$$
$$T = \text{J. D. } 2417168\cdot171 \pm \cdot011$$
$$a \sin i = 3{,}487{,}600 \text{ km.}$$

The data regarding the second component are collected in the following table.

DATA OF SECOND COMPONENT.

Plate.	Velocity Referred to Line.		Number lines.	Weight.	$\frac{m_s}{m}$
	Component I. (computed)	Component II.			
4,850	+72·9	−113·0	2	1	·65
5,219	−60·7	+150·9	2	1	·40
5,237	−62·4	+164·8	2	1	·38
5,313	−65·3	+140·4	2	1	·46
5,329	+73·9	−111·8	3	1	·66
5,348	−66·7	+163·3	7	3	·41
5,369	−58·8	+114·1	1	½	·52

The number of lines and weight refer of course to the second component. It is thus seen that the information we have regarding it is meagre indeed though there is no doubt as to its reality. The spectrum appears to be a duplicate of that of the main component. The ratio of the masses is given in the last column and the weighted mean gives

$$\frac{m_s}{m}=0\cdot 47$$

This ratio is much smaller than the average, the limited number already known varying from 0·7 to unity. The value of *m sin i* is 2·7. The probable error of a plate is ±3·44 km. per second. The curve represents the corrected elements, the grouped velocities being shown.

ADDENDUM.

In the interval between the completion of the foregoing and its publication in this extended form the determination of the same orbit by Wilson of the Lick observatory has come to hand. The star, as previously stated, was announced as a binary by Moore of the Lick observatory but before definitely commencing work on it here in February, 1912, we had the consent of Dr. Campbell to proceed with the determination. He suggested in a letter to Dr. Plaskett that as Dr. Moore was leaving for Santiago we had better take the star on our list. The period was determined by the writer on Sept. 19, 1912, but was not announced; otherwise the duplication of the work might have been avoided, as only one observation, outside of the original five, had been made at that time at the Lick.

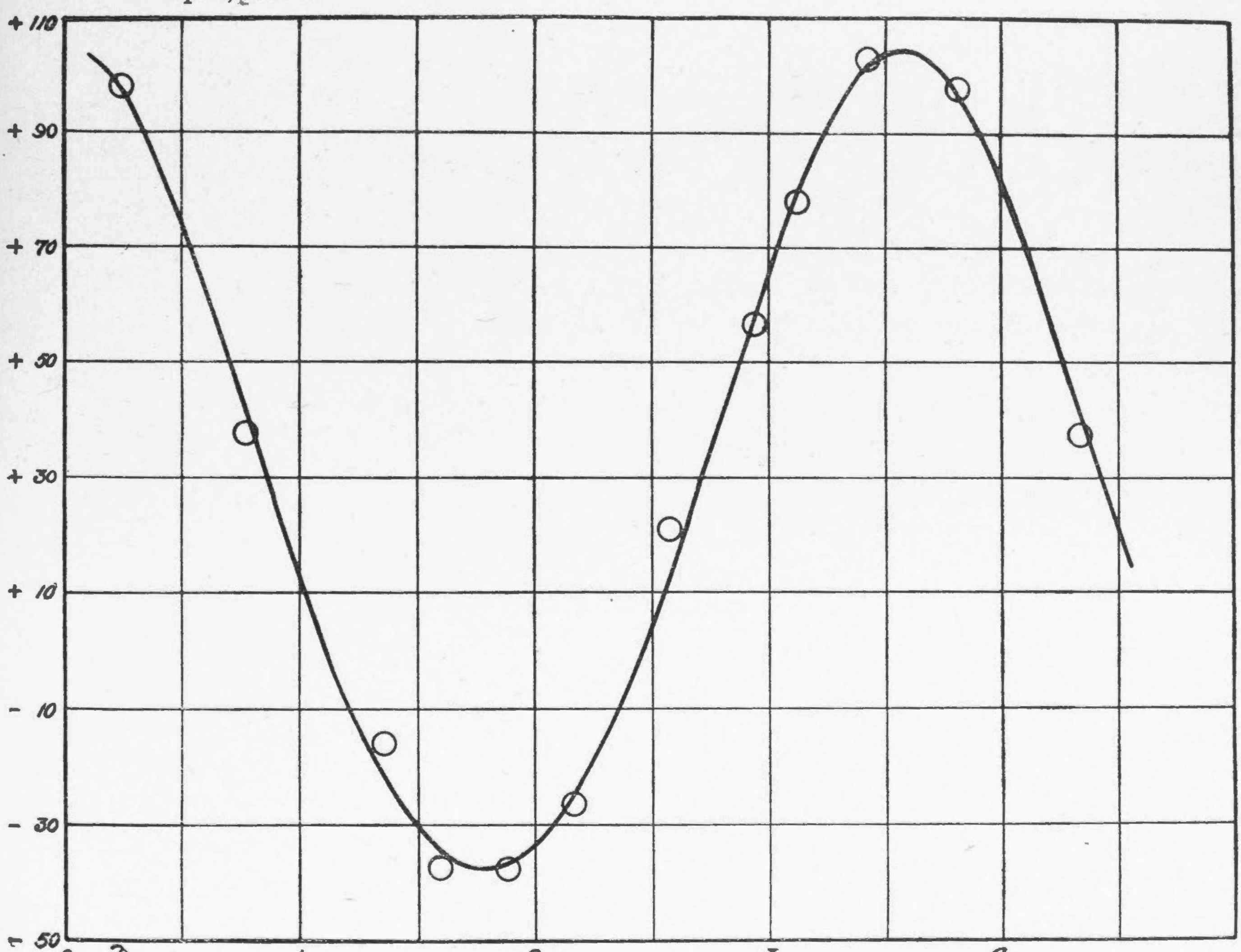
The elements as obtained by Wilson from 28 three-prism plates are as follows:—

$$P=3\cdot 57124 \text{ days}$$
$$e=0\cdot 0$$
$$K=76\cdot 32 \text{ km.}$$
$$\gamma=+28\cdot 69 \text{ km.}$$
$$a \sin i=3{,}748{,}000 \text{ km.}$$

Owing to the greater dispersion used, their plates have a much lower probable error (±1·2 km.) than ours (±3·4) and consequently the elements just given should be more nearly correct than our own. The only noticeable difference in the two determinations is in the negative maximum. Their curve shows a maximum negative value of 48 km. We have negative velocities of 41 and 42 km. but the solution reduces the maximum to about −38 km., so that there is this difference. Our eccentricity is 0·05; at Lick this is found to be 0·0. Though this difference is practically negligible it causes some of the discrepancy in the negative maximum, and this latter accounts wholly for the difference of 5 km. in K. The periods are the same. The maximum positive velocities are the same; the Ottawa maximum occurring 0·004 days later than the Lick.

One important item revealed by the Ottawa plates, and of which no mention is made in the Lick determination, is the presence of the second spectrum. While the lines are not of the best quality for measurement there is no doubt as to the reality of their presence, and thus we can determine the ratio of the masses of the two components.

April, 1913.



Velocity Curve of *d* Tauri.