DEPARTMENT OF THE INTERIOR

CANADA

HON. W. J. ROCHE, *Minister.* W. W. CORY, C.M.G., *Deputy Minister.*

PUBLICATIONS

OF THE

Dominion Observatory

OTTAWA

W. F. KING, C.M.G., LL.D., *Director.*

Vol II, No. 4

Orbit of 136 Tauri

BY

J. B. CANNON, M.A.

OTTAWA
GOVERNMENT PRINTING BUREAU
1915

76842—1

ORBIT OF 136 TAURI.

BY J. B. CANNON, M.A.

The variable radial velocity of the star was discovered by Mr. Lows from the measurement of the second plate of a series of five, the results of which are published in L.O.B. 199. The orbit determination given below is based on 60 plates obtained here—the first on November 16, 1911, and the last on January 15, 1915. The spectrum is of A-type. Two spectra are visible, but so faintly on our plates that they were not considered worth measuring. On four out of the five Lick plates, however, the second component is measured, and on these alone is based the secondary curve seen in the figure—"Velocity curve of 136 Tauri."

The lines measured were as follows:—

TABLE I.

Element.	Wave-Length.	Element	Wave-Length
H	4861·527	*H*	4101·890
Fe	4549·766	*H*	3970·177
Mg	4481·400	*Ca*	3968·625
H	4340·634	*Ca*	3933·825

A summary of the measures is given in Tables II and III. Table II contains the Lick observations and Table III the Ottawa observations. In each case the phase is from periastron and the residual from the final curve. Measures in detail of the different plates follow Table III.

TABLE II.

LICK OBSERVATIONS.

Julian Date.	Phase.	V_1	R_1	V_2	R_2
2,418,402·64	1·149	−21·0	+ 2·8	.....	.....
739·66	3·889	+ 3·8	+ 1·0	−51·7	− 2·5
945·03	0·340	−60·8	− 1·3	+34·0	− 7·0
950·02	5·329	−60·6	+ 1·0	+49·3	+ 5·3
952·99	2·329	+27·8	+ 2·0	−84·4	− 3·0

TABLE III.

OTTAWA OBSERVATIONS.

Plate.	Observer.*	Date.	Exposure.	Julian Day.	Phase.	Velocity.	Wt.	O-C
		1911	m.					
4697	H	Nov. 16.....	75	2,419,357·820	1·269	−11·0	5	+ 7·0
4718	C	Dec. 6.....	65	377·807	3·347	+22·6	3	− 0·4
		1912						
4840	H	Feb. 13.....	70	446·589	0·508	−43·6	3	+10·4
4851	H	Feb. 20.....	103	453·670	1·619	+10·0	4	+10·0
4860	C	Feb. 28.....	70	461·642	3·621	+12·5	7	− 1·8
4871	H	Mar. 5.....	96	467·661	3·670	+10·4	5	− 1·6
4885	C	Mar. 13.....	75	475·554	5·593	−60·1	2	+ 6·0
		1913						
5314	P	Jan. 12.....	85	780·717	0·367	−47·8	6	+10·7
5368	C	Feb. 11.....	70	810·580	0·390	−45·8	6	+12·2
5361	P	Feb. 12.....	75	811·630	1·439	− 7·5	6	+ 1·5
5371	P1	Feb. 17.....	75	816·612	0·451	−47·6	4	+ 8·4
5384	H	Feb. 18.....	72	817·610	1·449	− 6·1	5	+ 2·4
5393	C	Feb. 24.....	75	823·640	1·509	− 6·2	5	+ 1·0
5408	P1	Feb. 28.....	75	827·592	5·461	−58·9	5	+ 5·0
5417	C	Mar. 7.....	75	834·623	0·552	−42·9	2	+ 8·7
5434	H	Mar. 12.....	109	839·603	5·532	−69·8	6	− 9·6
5438	P1	Mar. 17.....	100	844·597	4·556	−29·3	2	+ 1·0
5455	C	April 9.....	70	867·545	3·634	+14·5	3	+ 0·5
5468	P1	April 14.....	75	872·561	2·680	+42·3	6	+11·7
5488	H	April 17.....	75	875·548	5·667	−59·9	4	+ 6·9
5850	C	Dec. 22.....	35	20,124·814	4·233	−10·8	5	+ 3·2
		1914						
5936	P	Feb. 14.....	60	178·656	4·355	−14·5	5	+ 5·5
5987	C	Mar. 20.....	73	212·638	2·517	+17·2	5	−12·0
6007	C	April 3.....	75	226·525	4·474	−26·5	7	− 0·5
6014	C	April 5.....	73	228·540	0·519	−66·3	7	−12·8
6015	H	April 6.....	75	229·560	1·539	−17·2	5	−13·2
6024	C	April 10.....	82	233·538	5·511	−72·0	5	− 7·0
6030	H	April 13.....	76	236·569	2·578	+28·1	5	− 1·8
6032	C	April 14.....	75	237·533	3·542	+19·1	4	+ 2·1
6035	P1	April 17.....	80	240·552	0·591	−68·0	4	−17·5

TABLE III.

OTTAWA OBSERVATIONS—*Concluded.*

Plate.	Observer.*	Date.	Exposure.	Julian Day.	Phase.	Velocity.	Wt.	O-C
		1914	m.					
6040	P¹	April 22.....	100	2,420,245·549	5·588	−64·4	5	+ 1·6
6046	H	April 23.....	66	246·540	0·609	−53·6	6	− 3·8
6053	C	May 1.....	70	254·559	2·658	+27·1	3	− 3·2
6396	Y	Sept. 17.....	72	393·841	4·653	−38·5	6	− 3·5
6404	P¹	Sept. 18.....	75	394·894	5·706	−64·0	5	+ 3·0
6420	C	Sept. 21.....	75	397·894	2·727	+26·6	5	− 4·2
6431	G	Sept. 25.....	75	401·911	0·775	−42·2	4	0·0
6436	Y	Sept. 27.....	50	403·927	2·801	+34·9	6	+ 4·1
6444	C	Sept. 28.....	70	404·913	3·787	+ 6·7	6	− 1·3
6451	C	Sept. 30.....	15	406·890	5·764	−70·3	5	− 3·3
6461	Y	Oct. 1.....	45	407·875	0·780	−39·1	6	+ 2·0
6471	P¹	Oct. 2.....	50	408·882	1·787	+15·4	5	+ 9·9
6484	H	Oct. 4.....	60	410·867	3·772	+13·1	3	+ 5·1
6490	Y	Oct. 11.....	55	417·929	4·788	−33·1	7	+ 8·0
6517	P¹	Oct. 21.....	75	427·878	2·876	+34·7	6	+ 4·7
6538	C	Oct. 28.....	55	434·939	3·968	−12·4	6	−11·7
6548	C	Nov. 2.....	60	439·934	2·994	+26·8	5	− 2·9
6564	H	Nov. 17.....	60	454·924	0·077	−63·4	6	+ 2·8
6574	P¹	Nov. 23.....	70	460·872	0·056	−72·1	6	− 6·1
6594	P	Dec. 4.....	130	471·840	5·055	−55·1	4	− 2·6
6600	Y	Dec. 5.....	60	472·806	0·052	−71·0	4	− 5·0
6607	H	Dec. 6.....	62	473·815	1·061	−30·4	3	− 2·0
6633	H	Dec. 15.....	66	482·939	4·216	−10·8	4	+ 1·7
6642	P¹	Dec. 16.....	85	483·946	5·223	−50·8	3	+ 7·2
6653	Y	Dec. 22.....	40	489·625	4·933	−57·5	3	− 9·5
6670	Y	Dec. 30.....	45	497·717	1·087	−32·7	7	− 5·0
6674	Y	Dec. 31.....	40	498·767	2·137	+19·6	6	− 1·0
		1915						
6695	P¹	Jan. 8.....	85	506·794	4·195	− 8·3	5	+ 3·7
6711	H	Jan. 12.....	60	510·786	2·218	+14·5	5	− 7·8
6715	P¹	Jan. 15.....	95	513·862	5·194	−53·5	2	+ 3·8

*H=Harper; C=Cannon; P=Plaskett; P¹=Parker; Y=Young; G=Gibson.

MEASURES OF 136 TAURI.

λ	4697		4718		4840		4851		4860		4871		4885	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	.....	....	.....	....	.....	....	.....	....	+ 42·08	¼	.....	....	.....	....
4549·766	− 33·35	¼	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....
4481·400	− 46·79	¼	+ 28·82	¼	+ 7·65	¼	+ 62·73	¼	+ 25·26	½	+ 42·20	¼	.....	....
4340·634	− 14·23	½	+ 11·92	½	− 9·37	1	+ 41·54	½	+ 46·16	1	+ 41·54	1	− 19·77	½
4101·890	− 26·00	¼	+ 23·11	¼	− 22·34	½	.....	....	.....	....	+ 31·62	¼	− 46·56	½
3933·825	− 23·63	½	+ 6·49	¼	− 20·72	1	+ 31·53	1½	+ 42·52	1	+ 40·52	¼	− 26·92	1
Weighted mean	− 26·62		+ 16·45		− 17·49		+ 37·22		+ 40·67		+ 40·07		− 30·04	
V_o	+ 16·13		+ 6·56		− 25·76		− 26·76		− 27·67		− 29·11		− 29·67	
V_d	− ·18		− ·11		− ·06		− ·20		− ·19		− ·23		− ·13	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 11·0		+ 22·6		− 43·6		+ 10·0		+ 12·5		+ 10·4		− 60·1	

MEASURES OF 136 TAURI.—*Continued.*

λ	5314		5368		5361		5371		5384		5384*		5393	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	.....	....	.....	....	.....	....	.....	....	+ 38·55	¼	+ 34·02	¼	+ 29·96	¼
4481·400	− 29·58	½	− 10·20	¼	+ 20·14	¼	− 3·44	½	+ 37·10	½	+ 23·97	½	.....	....
4340·634	− 37·48	½	− 22·56	¼	+ 17·82	1	− 20·94	½	+ 22·44	1	+ 16·43	1	+ 28·81	½
4101·890	− 29·37	¼	.....	....	+ 24·27	¼	− 15·21	¼	+ 13·39	½	+ 12·23	½	+ 10·50	½
3970·177	.....	....	− 20·36	½	.....	....	.....	....	.....	....	.....	....	+ 19·61	¼
3968·625	.....	....	− 14·45	¼	.....	....	.....	....	.....	....	.....	....	.....	....
3933·825	− 36·94	1	− 29·29	½	+ 15·64	1	− 31·12	1	+ 16·56	1½	+ 24·87	2	+ 20·38	1
Weighted mean	− 34·58		− 20·93		+ 17·82		− 20·94		+ 21·90		+ 19·48		+ 20·97	
V_o	− 12·80		− 24·59		− 24·89		− 26·22		− 26·46		− 26·46		− 27·75	
V_d	− ·11		− ·04		− ·14		− ·13		− ·09		− ·09		− ·14	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 47·8		− 45·8		− 7·5		− 47·6		− 4·9		− 7·3		− 6·2	

*Check measures.

MEASURES OF 136 TAURI.—*Continued.*

λ	5408		5417		5434		5438		5455		5468		5488	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4861·527	− 42·72	½	.....	....	− 37·90	¼	− 23·13	¼	.....	....	.....	....	.....	....
4549·766	.....	....	.....	....	.....	....	+ 1·47	¼	.....	....	.....	....	.....	....
4481·400	− 21·29	½	.....	....	− 40·83	¼	+ 27·41	¼	+ 18·10	¼	+ 74·97	½	− 39·01	¼
4340·634	− 35·64	¼	− 10·87	1	− 52·76	¼	− 0·23	½	+ 41·42	½	+ 65·60	½	− 18·16	¼
4101·890	.....	....	− 0·58	½	− 19·68	½	− 1·06	¼	+ 19·16	¼	.....	....	− 30·91	¼
3970·177	.....	....	.....	....	.....	....	.....	....	+ 57·96	¼	.....	....	.....	....
3968·625	.....	....	.....	....	.....	....	.....	....	+ 32·04	¼	.....	....	.....	....
3933·825	− 29·87	½	− 21·63	1	− 46·84	1	+ 1·83	¼	+ 52·58	1	+ 65·56	½	− 40·19	½
Weighted mean	− 30·11		− 13·24		− 39·80		+ 0·89		+ 42·04		+ 68·71		− 33·70	
V_o	− 28·42		− 29·25		− 29·64		− 29·73		− 27·10		− 25·94		− 25·69	
V_d	− ·10		− ·14		− ·14		− ·19		− ·20		− ·23		− ·23	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 58·9		− 42·9		− 69·8		− 29·3		+ 14·5		+ 42·3		− 59·9	

MEASURES OF 136 TAURI.—*Continued.*

λ	5850		5936		5987		6007		6014		6015		6024	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	.....	....	− 1·19	¼	.....	....	− 13·44	¼	− 28·20	¼	− 2·24	¼	.....	....
4481·400	− 3·01	½	+ 11·08	½	+ 44·44	¼	− 3·15	½	− 35·88	¼	+ 21·15	¼	− 37·52	¼
4340·634	− 17·27	½	+ 11·14	1	+ 43·43	½	+ 3·07	½	− 43·32	½	+ 4·66	½	− 44·80	½
4101·890	− 6·01	1	+ 31·52	¼	+ 28·04	¼	+ 6·77	¼	− 40·93	½	+ 8·09	½	− 47·05	⅛
3970·177	.....	....	.....	....	.....	....	.....	....	.....	....	+ 13·99	¼	.....	....
3968·625	.....	....	.....	....	.....	....	+ 6·00	¼	.....	....	+ 22·05	¼	.....	....
3933·825	− 9·96	¼	+ 6·83	½	+ 54·56	1	+ 7·00	1	− 35·72	1	+ 10·70	1	− 44·94	1
Weighted mean	− 8·28		+ 11·07		+ 47·20		+ 2·47		− 37·54		+ 11·41		− 43·94	
V_a	− 2·08		− 25·15		− 29·48		− 28·56		− 28·25		− 28·08		− 27·55	
V_d	− ·17		− ·16		− ·25		− ·16		− ·19		− ·22		− ·20	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 10·8		− 14·5		+ 17·2		− 26·5		− 66·3		− 17·2		− 72·0	

MEASURES OF 136 TAURI.—*Continued.*

λ	6030		6032		6035		6040		6046		6053		6396	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481·400	+ 23·72	¼	+ 36·64	½	− 41·17	½	.....	....	− 28·45	¼	.....	....	− 50·25	¼
4340·634	+ 60·15	½	+ 54·69	¼	− 45·37	½	− 35·75	1	− 22·85	½	+ 58·79	⅛	− 75·67	½
4101·890	+ 53·30	½	+ 38·20	¼	.....	....	− 50·34	½	− 50·91	¼	+ 61·14	¼	− 69·88	¼
3970·177	.....	....	.....	....	.....	....	.....	....	.....	....	+ 46·20	¼	.....	....
3933·825	+ 61·89	1	+ 49·38	1	− 38·76	½	− 37·86	1	− 26·75	1	+ 21·89	⅛	− 67·26	½
Weighted mean	+ 55·37		+ 45·46		− 41·76		− 39·51		− 29·00		+ 49·23		− 67·67	
V_a	− 26·71		− 26·00		− 25·76		− 24·40		− 24·10		− 21·54		+ 29·48	
V_d	− ·23		− ·22		− ·24		− ·24		− ·24		− ·27		+ ·17	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 28·1		+ 19·1		− 68·0		− 64·4		− 53·6		+ 27·1		− 38·5	

MEASURES OF 136 TAURI.—*Continued.*

λ	6404		6420		6431		6436		6444		6451		6461	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	.....	....	.....	....	.....	....	.....	....	− 38·95	¼	.....	....	.....	....
4481·400	−118·59	¼	+ 13·22	¼	.....	....	+ 1·87	¼	− 26·56	¼	−118·96	¼	− 46·89	¼
4340·634	− 92·78	½	− 0·11	½	− 61·25	¼	+ 9·35	½	− 14·53	½	− 80·17	¼	− 70·83	½
4101·890	− 78·32	¼	+ 9·28	½	− 81·20	¼	+ 3·80	½	− 24·31	¼	−103·01	¼	− 72·01	¼
3970·177	.....	....	.....	....	.....	....	+ 7·49	¼	.....	....	.....	....	.....	....
3968·625	.....	....	.....	....	.....	....	+ 0·49	¼	.....	....	.....	....	.....	....
3933·825	− 88·64	½	− 1·67	1	− 71·79	¼	+ 8·51	½	− 18·44	½	− 94·60	¼	− 70·52	1
Weighted mean	− 93·29		− 2·76		− 71·41		+ 5·91		− 22·25		− 99·18		− 67·83	
V_o	+ 29·48		+ 29·50		+ 29·38		+ 29·26		+ 29·21		+ 29·04		+ 28·93	
V_d	+ ·11		+ ·11		+ ·08		+ ·01		+ ·04		+ ·07		+ ·08	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 64·0		+ 26·6		− 42·2		+ 34·9		+ 6·7		− 70·3		− 39·1	

MEASURES OF 136 TAURI.—*Continued.*

λ	6471		6484		6490		6517		6538		6548		6564	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481·400	− 7·86	¼	− 4·86	¼	− 59·11	¼	+ 8·35	¼	− 46·89	¼	− 3·62	¼	− 60·11	¼
4340·634	− 26·91	½	− 25·56	½	− 55·40	¼	+ 11·37	½	− 26·80	½	− 3·94	½	− 73·42	½
4101·890	− 6·03	½	− 2·78	¼	− 64·31	½	+ 1·39	¼	− 23·85	¼	+ 3·53	¼	− 94·93	½
3970·177	.....	....	.....	....	.....	....	+ 4·53	¼	.....	....	.....	....	.....	....
3968·625	.....	....	.....	....	− 64·44	¼	+ 10·85	¼	.....	....	.....	....	.....	....
3933·825	− 11·37	1	− 16·54	½	− 53·90	¼	+ 14·87	½	− 39·35	1	+ 15·50	1	− 78·31	1
Weighted mean	− 13·25		− 15·30		− 60·25		+ 9·70		− 35·21		+ 5·60		− 78·89	
V_a	+ 28·84		+ 28·61		+ 27·51		+ 25·27		+ 23·20		+ 21·64		+ 15·52	
V_d	+ ·07		+ ·08		− ·06		− ·02		− ·15		− ·18		− ·21	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	+ 15·4		+ 13·1		− 33·1		+ 34·7		− 12·4		+ 26·8		− 63·4	

MEASURES OF 136 TAURI.—*Continued.*

λ	6574		6594		6600		6607		6633		6642		6653	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4481·400	− 99·66	¼	− 76·75	¼	− 94·65	¼	− 18·78	¼	− 9·89	½	− 27·17	¼	− 61·35	½
4340·634	− 79·17	¼	− 67·07	½	− 67·52	½	− 54·55	½	− 11·76	½	− 57·68	½	− 48·86	¼
4101·890	− 91·90	¼	− 50·57	½	− 71·84	½	− 27·88	¼	.....	....	.....	....	− 50·10	¼
3970·177	− 69·14	¼	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....
3968·625	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....	− 38·90	½
3933·825	− 83·97	1	− 61·76	1	− 84·37	½	− 31·24	½	− 14·22	½	− 63·05	¼	− 62·96	½
Weighted mean	− 84·46		− 62·12		− 77·44		− 36·37		− 11·95		− 51·39		− 55·22	
V_a	+ 12·80		+ 7·42		+ 6·83		+ 6·41		+ 1·67		+ 1·14		− 1·85	
V_d	− ·18		− ·16		− ·11		− ·12		− ·28		− ·29		− ·14	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		− ·28		− ·28	
Radial Velocity	− 72·1		− 55·1		− 71·0		− 30·4		− 10·8		− 50·8		− 57·5	

MEASURES OF 136 TAURI.—*Concluded.*

λ	6670		6674		6695		6711		6715					
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4549·766	− 27·95	¼	+ 23·04	½	.....	....	.....	....	− 42·51	¼	.....	....	.....	....
4481·400	− 21·41	½	+ 23·41	½	+ 8·76	¼	+ 17·53	½	− 50·08	¼	.....	....	.....	....
4340·634	− 37·32	½	+ 45·53	¼	+ 1·36	½	+ 25·22	¼	− 11·99	¼	.....	....	.....	....
4101·890	− 27·43	¼	.....	....	− 10·54	½	+ 13·06	¼	.....	....	.....	....	.....	....
3933·825	− 22·61	1	+ 25·33	1	+ 8·47	1	+ 36·91	1	− 51·15	¼	.....	....	.....	....
Weighted mean	− 26·33		+ 26·64		+ 2·82		+ 27·62		− 38·93		.....		.....	
V_o	− 6·07		− 6·61		− 10·66		− 12·60		− 14·05		.....		.....	
V_d	− ·07		− ·17		− ·22		− ·22		− ·28		.....		.....	
Curv.	− ·28		− ·28		− ·28		− ·28		− ·28		.....		.....	
Radial Velocity	− 32·7		+ 19·6		− 8·3		+ 14·5		− 53·5		.....		.....	

The sixty observations were grouped into twelve normal places. The normal places are given below in Table IV together with the mean Julian day, mean phase from periastron, mean velocity, weight and residual from final curve.

TABLE IV.

NORMAL PLACES.

No.	Julian Day.	Phase.	Velocity.	Weight.	Residual.
1	2,419,970·118	0·490	−53·3	3·0	+1·0
2	2,420,448·018	0·929	−36·2	1·5	−1·0
3	2,419,808·190	1·441	− 9·5	2·0	−0·5
4	2,420,267·281	1·966	+15·4	1·5	+0·8
5	2,420,118·162	2·607	+29·6	1·5	−0·3
6	2,420,417·271	2·848	+31·1	2·0	+0·5
7	2,419,868·535	3·640	+13·1	2·5	−0·5
8	2,420,343·708	4·183	−11·4	2·0	−0·6
9	2,420,298·792	4·630	−32·1	2·0	+1·3
10	2,420,486·316	5·090	−54·4	1·0	−0·8
11	2,419,963·863	5·550	−65·0	2·0	+0·4
12	2,420,438·266	5·918	−68·0	2·0	−1·4

The preliminary elements obtained from these by Dr. King's graphic method were as follows:—

$P = 5{\cdot}969$ days
$e = {\cdot}02$
$\omega = 190°$
$K = 49{\cdot}5$ km.
$\gamma = -17{\cdot}5$ km.
$T = 2{,}419{,}362{\cdot}52$ J. D.

A closer approximation to the curve was attempted by applying a least-squares solution. The period of oscillation was taken as fixed, being obtained by using both Lick and Ottawa observations, which being far apart, cover a great many cycles. On account of e being very small, T was also taken as fixed and e, ω, K, and γ used in the solution.

Observation equations were formed as in Table V.

TABLE V.

OBSERVATION EQUATIONS.

x	y	z	u	$-n$	Weight.
1	−·778	−·313	+·666	−2·7	·3
1	−·395	+·595	+·930	−0·9	1·5
1	+·140	+·991	+·991	−1·1	2·0
1	+·630	+·317	+·763	−1·7	1·5
1	+·959	−·832	+·210	+0·3	1·5
1	+·980	−·995	−·032	−0·1	2·0
1	+·647	−·073	−·741	+1·4	2·5
1	+·152	+·863	−·982	+1·4	2·0
1	−·309	+·917	−·953	−0·7	2·0
1	−·728	+·176	−·702	+0·8	1·0
1	−·980	−·734	−·277	−1·0	2·0
1	−1·013	−·851	+·122	+0·3	2·0

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

Normal equations resulting from these observation equations were as follows:—

$$\begin{aligned} 23x - 1{\cdot}713y - 0{\cdot}444z + 0{\cdot}037u - 9{\cdot}650 &= 0 \\ 11{\cdot}711y + 0{\cdot}421z - 0{\cdot}970u + 9{\cdot}050 &= 0 \\ 11{\cdot}700z - 0{\cdot}900u + 0{\cdot}545 &= 0 \\ 11{\cdot}327u - 14{\cdot}621 &= 0 \end{aligned}$$

Solving these gave,

$$\begin{aligned} x &= +\ {\cdot}37 \\ y &= -\ {\cdot}62 \\ z &= +\ {\cdot}085 \\ u &= +1{\cdot}244 \end{aligned}$$

from which,

$$\begin{aligned} \delta\gamma &= +\ {\cdot}37 \text{ km.} \\ \delta K &= -\ {\cdot}62 \text{ km.} \\ \delta e &= +\ {\cdot}0017 \\ \delta\omega &= +1^\circ{\cdot}44 \end{aligned}$$

and hence the new values of the elements,

$$\begin{aligned} P &= 5{\cdot}969 \text{ days} \\ e &= {\cdot}0217 \\ \omega &= 191^\circ{\cdot}44 \\ \gamma &= -17{\cdot}13 \text{ km.} \\ K &= 48{\cdot}88 \text{ km.} \\ T &= 2{,}419{,}362{\cdot}52 \text{ J. D.} \end{aligned}$$

The value of Σpvv was reduced from 25 to 16 — a very substantial reduction. Excellent agreement between computed and observation equation residuals showed that any further solution would be useless, and these elements were accepted as final.

The following table (Table VI) contains a summary of preliminary and final values together with the probable errors of each element.

TABLE VI.

Element.	Preliminary.	Final.	Probable Error.
P	5·969 days	5·969 days	
e	·02	·0217	± ·014
ω	190°	191°·44	± 0°·88
K	49·5 km.	48·9 km.	± ·73 km.
γ	−17·5 km.	−17·1 km.	± ·52 km.
T	2,419,362·52 J. D.	2,419,362·52 J. D.	.....
$a \sin i$	.....	4,011,000 km.	.....

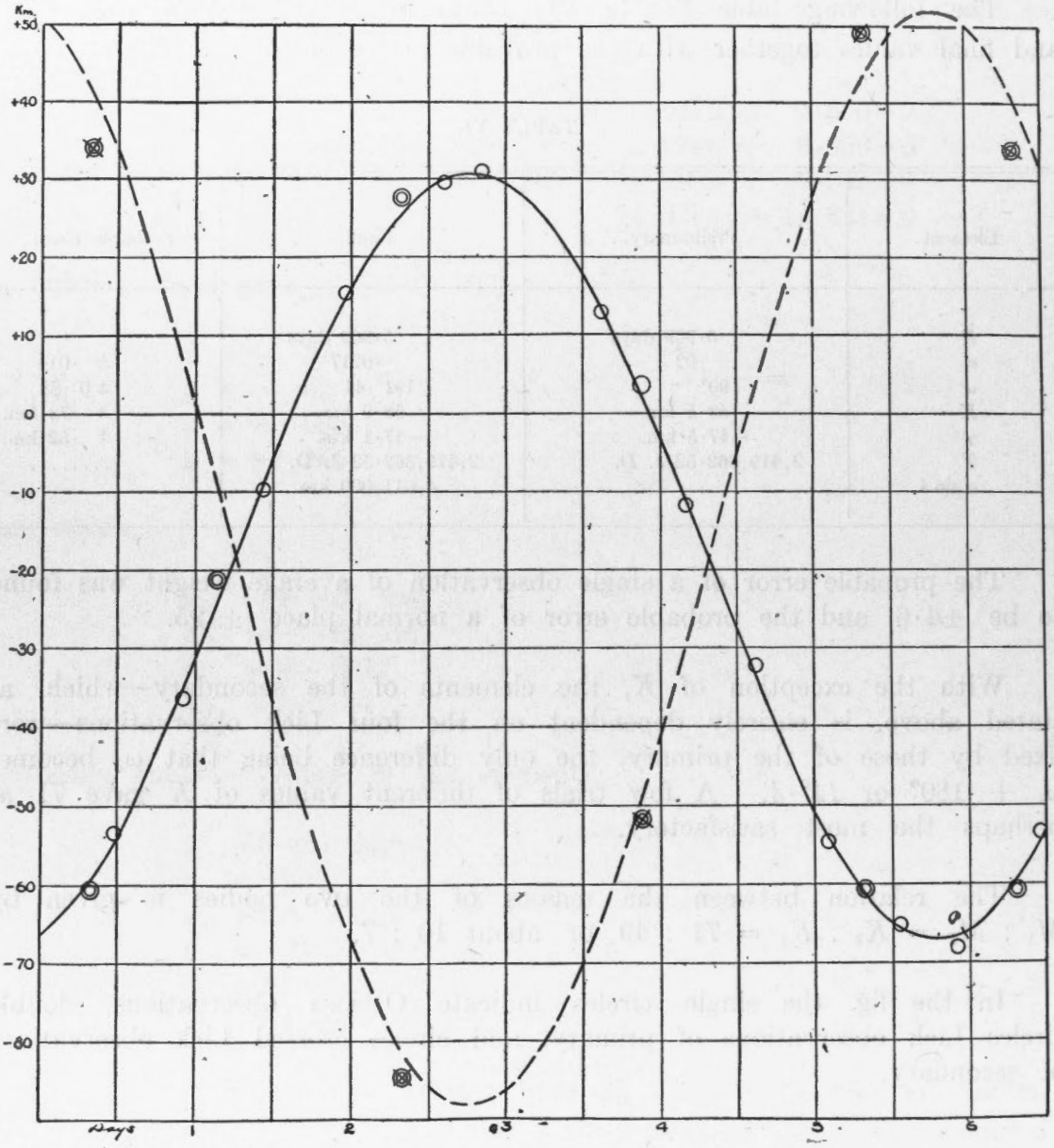
The probable error of a single observation of average weight was found to be ±4·6, and the probable error of a normal place ±·95.

With the exception of K, the elements of the secondary—which, as stated above, is entirely dependent on the four Lick observations—were fixed by those of the primary, the only difference being that ω_2 becomes $\omega_1 + 180°$ or $11°{\cdot}4$. A few trials of different values of K gave 71 as perhaps the most satisfactory.

The relation between the masses of the two bodies is given by $M_1 : M_2 = K_2 : K_1 = 71 : 49$ or about 10 : 7.

In the fig. the single circles indicate Ottawa observations, double circles Lick observations of primary, and circles crossed Lick observations of secondary.

Dominion Observatory,
Ottawa,
February, 1915.



Velocity Curve of 136 Tauri.