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ORBIT OF THE SPECTROSCOPIC BINARY 19 LYNCIS

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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 = 2·25960 days
e = ·05
ω = 120°
K = 105 km.
γ = + 7·12 km.
T = J. D. 2,419,031·596

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

$x = \delta\gamma$
$y = \delta K$
$z = K.\delta e$
$u = K.\delta\omega$
$v = [2\cdot46688].\delta T$

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,

$$\begin{aligned}
6{\cdot}100x + {\cdot}904y - {\cdot}122z - {\cdot}357u + {\cdot}385v - {\cdot}710 &= 0\\
2{\cdot}841y - {\cdot}118z + {\cdot}126u - {\cdot}175v + 2{\cdot}165 &= 0\\
2{\cdot}183z - {\cdot}042u + {\cdot}107v - 6{\cdot}769 &= 0\\
3{\cdot}230u - 3{\cdot}220v - 1{\cdot}876 &= 0\\
3{\cdot}220v + 1{\cdot}546 &= 0
\end{aligned}$$

which gave the following small corrections to the preliminary values,

$$\begin{aligned}
\delta\gamma &= +\ 0{\cdot}25 \text{ km.}\\
\delta K &= -\ 0{\cdot}57 \text{ km.}\\
\delta e &= +\ 0{\cdot}026\\
\delta\omega &= +\ 6^\circ{\cdot}11\\
\delta T &= +\ 0{\cdot}036 \text{ day}
\end{aligned}$$

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

$$\begin{aligned}
P &= 2{\cdot}25960 \text{ days}\\
e &= {\cdot}076\\
\omega &= 126^\circ{\cdot}11\\
\gamma &= +\ 7{\cdot}37 \text{ km.}\\
K &= 104{\cdot}43 \text{ km.}\\
T &= \text{J. D. } 2{,}419{,}031{\cdot}632\\
a \sin i &= 3{,}235{,}400 \text{ km.}\\
\frac{m_1{}^3 \sin^3 i}{(m+m_1)^2} &= 0{\cdot}26\odot
\end{aligned}$$

Dominion Observatory
Ottawa
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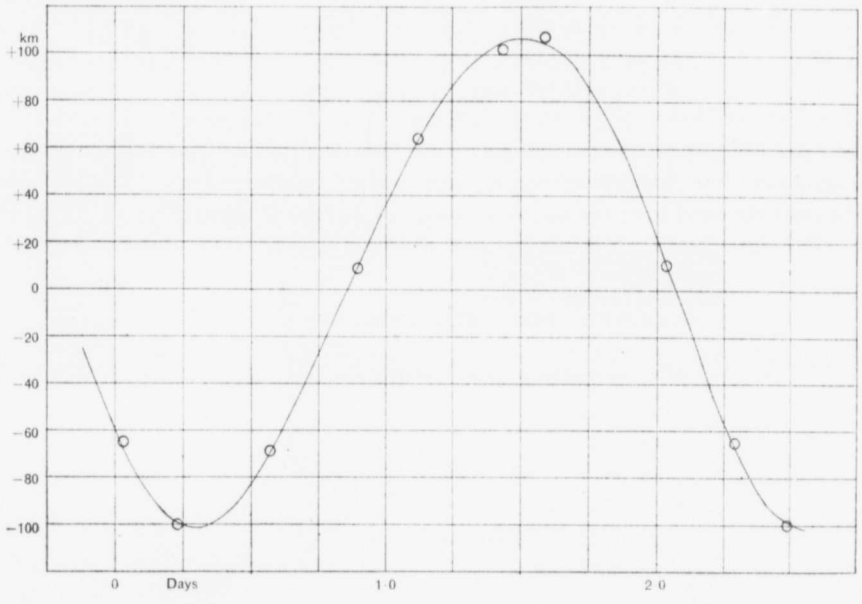

Radial Velocity Curve of 19 Lyncis