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Apsidal motion in the binary Delta Orionis

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ABSTRACT

A velocity curve of the spectroscopic binary 'Delta Orionis' has been obtained from the spectrograms taken at Kodaikanal during the years 1968-70. The orbital elements derived are in good agreement with earlier values except for the longitude of periastron 'ω'. The period of rotation of the line of apsides is found to be 208 years.

Key Words: Spectroscopic binary—Delta Orionis—Apsidal motion

INTRODUCTION

The star Delta Orionis is a well known spectroscopic binary, which has drawn the attention of several investigators [J. Hartmann, (1904), F. C. Jordan (1914), R. H. Curtiss (1914), A. Hnatek (1920), W. J. Luyten, O. Struve and W. W. Morgan (1939), P. Pismis, G. Haro and O. Struve (1950), G. R. Miczaika (1951)] The values of P, e and K found by all these investigators are in good agreement except that Miczaika finds a lower value for K and e. There is some evidence for apsidal rotation, but there is too large a scatter in the values of the longitude of periastron ω, to reach any conclusion. Since the last investigation of this system was that of Miczaika in 1950, the star was placed on the regular binary star programme of the Kodaikanal Observatory.

OBSERVATIONS

The spectrograms were taken on Eastman Kodak IIa-O emulsion, during the period 1968-70 with the grating spectrograph attached to the 50cm Cassegrain reflector. The projected slit width was 20 microns and the spectra had a dispersion of 47Å/mm at λ 4340Å. All the spectra were measured by one observer (VN). The wavelengths used for radial velocity determination are listed in Table 1. The observations are given in Table 2. The phases where computed from

$$To = JD\ 2428382.263 + 5^d.732357$$

following Pismis, Haro and Struve. The observations were then combined into eleven normal places of equal weight and are listed in Table 3.

TABLE 1

Wavelengths used for radial velocity determination

Wavelength Å	Line
4471.48	HeI
4340.47	Hγ
4101.74	Hδ

Wavelength Å	Line
4026.36	HeI
3970.07	Hε
3889.05	H8

TABLE 2

Radial Velocity measures of Delta Orionis

Plate No.	Julian Day of Observation	Phase from Node (Period)	Radial Velocity Km/Sec.	No. of lines measured
	2440000 +			
847	216.616	0.413	— 71	5
53	218.326	781	+ 49	6
57	222.422	496	— 77	5
59	223.228	636	— 35	6
66	226.099	137	+ 98	6
884	230.385	0.885	+ 92	4
93	232.153	193	+ 60	6
904	234.142	543	— 76	5
10	239.131	411	— 88	5
11	239.153	415	— 59	4
915	240.126	0.584	— 52	3
26	243.133	109	+105	6
38	247.334	842	+ 81	6
50	250.286	357	— 69	4
53	256.226	393	— 75	6
958	264.181	0.781	+ 35	6
68	268.142	472	— 81	6
76	271.276	018	+104	6
79	272.097	162	+ 64	6
88	273.228	359	— 63	5

Plate No.	Julian Day of Observation	Phase from Node (Period)	Radial Velocity Km/Sec.	No. of lines measured
	2440000 +			
995	274.214	0.531	— 91	6
1005	279.229	406	— 41	4
15	282.161	917	+106	6
21	283.169	093	+ 95	6
27	284.181	270	— 05	6
1030	288.164	0.964	+ 97	6
45	293.152	835	+ 44	6
1119	590.104	637	— 36	5
27	591.097	810	+ 40	5
31	591.319	849	+ 55	5
1136	592.163	0.996	+142	4
39	592.364	031	+103	5
40	593.194	176	+ 59	5
43	594.146	342	— 17	4
51	597.308	894	+ 87	4
1159	598.262	0.060	+ 89	6
85	614.292	857	+ 90	5
89	618.242	546	— 94	6
94	624.260	596	— 52	4
98	630.251	641	— 42	5
1199	631.143	0.796	+ 65	4
1202	632.214	983	+ 87	4
05	633.215	158	+ 72	5
08	643.226	904	+ 68	5
11	644.206	075	+112	5
1217	648.221	0.776	+ 19	5
23	650.235	127	+ 90	4
26	651.228	300	— 39	4
29	655.163	987	+115	5

TABLE 3

Normal points

Phase from node	Radial Velocity (Observed) Km/Sec.	Radial Velocity (Calculated) Km/Sec.	O–C Km/Sec
0.00	+108	+109	— 1
10	+ 98	+ 95	+ 3
17	+ 94	+ 64	0
30	— 20	— 22	+ 2
39	— 67	— 69	+ 2
51	— 82	— 81	— 1
58	— 66	— 63	— 3
64	— 38	— 37	— 1
79	+ 41	+ 41	0
85	+ 68	+ 70	— 2
90	+ 88	+ 89	— 1

ORBITAL ELEMENTS

The preliminary orbital elements were obtained by the Lehman–Filhes method and the elements were corrected by a least square solution following Sterne (1941). The preliminary and final elements with their probable errors are given below:

Elements	Preliminary	Final
γ	+ 15 Km/Sec.	+ 14·8 ± ·5 Km/Sec
K	97·0 Km/Sec.	96·5 ± ·7 Km/Sec
e	0·000	0·066 ± ·005
ω	———	106°58′ ± 14°30′
To	JD 2440437·41	JD 2440437·41 ± ·01

The computed velocity curve along with the normal points is shown in Figure 1.

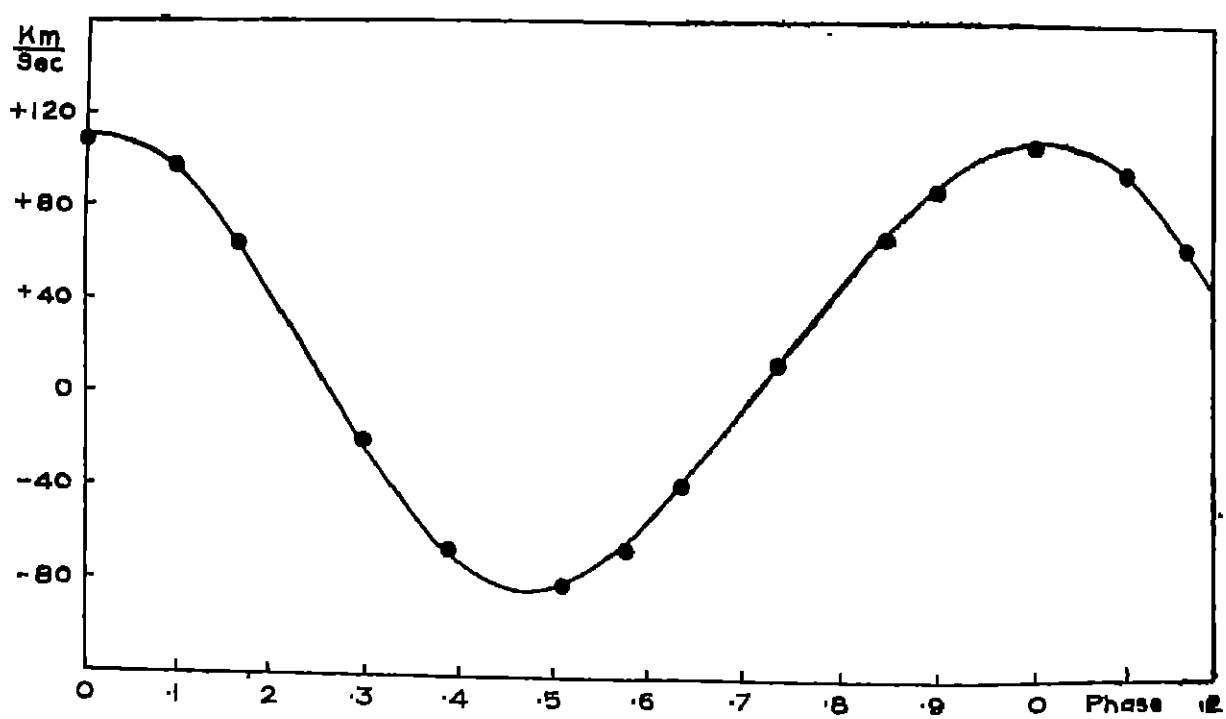

Fig.1 RADIAL VELOCITY CURVE OF DELTA ORIONIS

Luyten, Struve and Morgan have discussed the earlier observations and tabulated the elements obtained by various investigators. The subsequent investigations together with the present one have been added to the above table and are given in Table 4 for ready comparison.

TABLE 4

Observatory	Epoch (Year)	No. of Observations	ω (Degrees)	γ Km/Sec.	K Km/Sec.	e	To Julian Day.
POTSDAM	1902·14	24	355	+22	100·5	0·080	2415799·43
POTSDAM	03·05	13	352	21	102·0	0·136	16131·96
ALLEGHENY	10·84	36	0	15	100·0	0·090	18981·02
MICHIGAN	13·10	74	359	20	101·0	0·097	19806·39
VIENNA	20·19	17	351	19	99·5	0·130	22391·82
YERKES	36·52	140	38	12	101·0	0·079	28382·26
McDONALD	47·95	48	71	12	99·7	0·085	32509·47
HEIDELBERG	51·00	73	352	13	88·6	0·047	33656·11
KODAIKANAL	69·58	49	107	15	96·5	0·066	40437·41

Figure 2 is a plot of the longitude of periastron ω and the year of its determination. Excepting the values of ω determined at Vienna and Heidelberg (by A. Hnatek and G. R. Miczaika respectively), the rest fall on a straight line with the slope 1°·73/year. We derive from this value a period of apsidal rotation of 208 years.

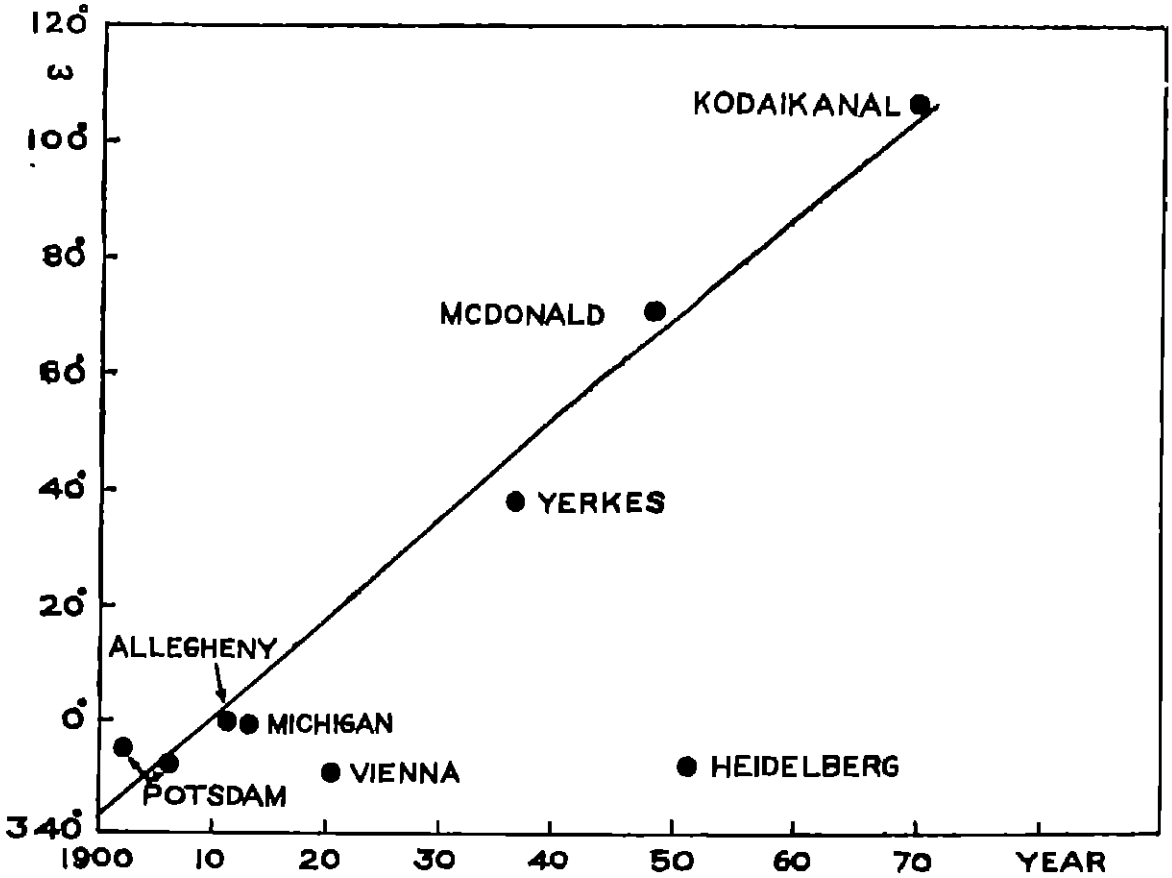

Fig. 2 Change in ω with Time

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REFERENCES

Curtiss, R. H., 1914, Publ. Obs. Univ. Michigan, **1**, 118.

Hartmann, J., 1904, Astrophys. J., **19**, 268

Hnatek, A., 1920, Astr. Nachr., **213**, 17

Jordan, F. C., 1914, Publ. Allegheny Obs., **3**, 125

Luyten, W. J., Struve, O and Morgan W. W., 1939, Publ. Yerkes Obs., 7—pt. IV, 256

Miczaika, G. R., 1951, Z. Astrophys., **30**, 299

PismisP., Haro G and Struve O., 1950, Astrophys. J. **111**, 509

Sterne T., 1941, Proc. Nat. Acad. Sci., **27**, 175

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