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SECULAR ACCELERATIONS IN THE LONGITUDES OF THE SATELLITES OF MARS

By BEVAN P. SHARPLESS

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Numerical values for the orbital elements of the satellites of Mars were derived by H. Struve,[1,2] Burton[3] and others. On page 160 of Burton's paper are found tables of the observed longitudes of the satellites with reduction to the common epoch 1900.0. The tables also contain the probable errors of the observed longitudes. It is intended to use these data and, in addition, unpublished material resulting from solutions of observations made at Washington in 1939 and 1941, to investigate the possibility of accelerations of the longitudes of the satellites.

Burton assumed the following values for longitude at epoch and mean daily motion, which for convenience will be used here:

	Long. at 1900.0	Mean Daily Motion
Deimos	286°70	285°16190
Phobos	19.67	1128.84413

Since there is a large variation in the probable errors of individually observed longitudes and since the observations occur in groups, it will be convenient to take group means by weighting in accordance with the probable errors. We then have five group means (taking off the longitudes at 1900 given above):

Deimos

Date	Days from 1900.0	Δl	p.e.
1879.16	− 7610.2	−0°45	±°07
1894.79	− 1901.5	−0.03	±.04
1909.72	+ 3551.2	+0.36	±.02
1926.17	+ 9559.0	+0.10	±.03
1941.66	+15217.7	+0.40	±.04

Phobos

Date	Days from 1900.0	Δl	p.e.
1879.23	− 7587.8	+0°60	±°21
1894.46	− 2022.9	−0.26	±.08
1909.69	+ 3540.6	−0.49	±.09
1925.26	+ 9225.5	+0.41	±.10
1941.66	+15214.8	+2.24	±.13

Solving conditional equations of the form

$$a + b(t_d - 1900.0) + c(t_y - 1900.0)^2 = \Delta l$$

where t_d, t_y = time measured in days and years respectively, and giving equal weight to each equation, we find

	Deimos	Phobos
a	+0°057 ± °097	−0°467 ± °100
b	+0°000047 ± °000013	−0°000037 ± °000013
c	−0°000266 ± °000164	+0°001882 ± °000171

Solution	[vv]	p.e. 1	[vv]	p.e. 1
Linear	0.1443	±°148	2.9776	±°672
Parabolic	0.0854	±°139	0.0120	±°050

In the case of Deimos it is seen that little improvement is obtained from the parabolic solution. If an acceleration exists, more observations

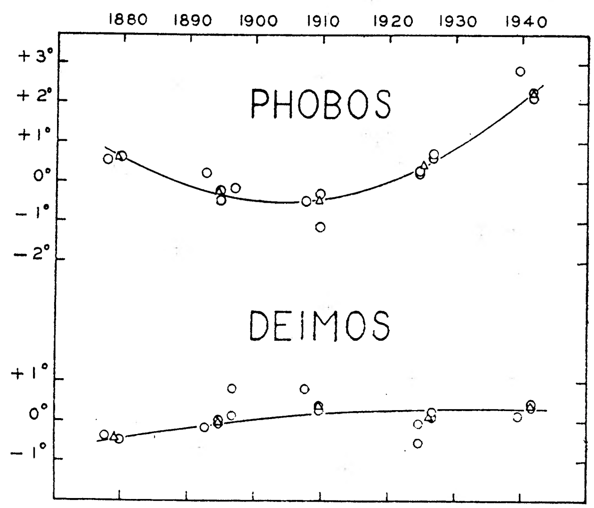

Figure 1. Residuals in orbital longitude. The circles represent opposition normals by instruments. The triangles represent group means. The curves are the result of the parabolic solutions.

will be required to confirm it. The results for Phobos show a marked improvement when the parabolic term is included. The coefficient of the square of the time comes out about eleven times its probable error. An improvement in the place of the satellite will result if we include this term; in fact it is necessary if we wish to predict the position of the satellite accurately in the latter half of the twentieth century.

It is not intended that this should be considered a definitive solution for the motion in longitude. The expression for the longitude contains a periodic term which is subject to revision. The effect of the fluctuation in astronomical time was examined, and it was found that it was nearly linear over the period of time under consideration. A trial solution showed only negligible effects on the accelerations.

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U. S. Naval Observatory,
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1945 *July.*

OBSERVATIONS OF FV CARINAE

1875: −10h 38m, −61° 18′

By HAROLD L. ALDEN

The following observations of the eclipsing variable FV Carinae are in continuation of those previously published in this journal.[1] They have been made and treated in the same manner as before, the mean epochs of minimum having been formed in the way described in that paper.

Table I contains the heliocentric time of the mid-exposure, the estimated magnitude, and the exposure time in minutes. Table II gives the weighted mean epochs of minimum for each year, the observations on each night being reduced to the same epoch with an approximate period. The residuals given under I and II are from the corresponding formulae and form a continuation of Table III of the earlier paper.

The former residuals indicate that a longer period is necessary to satisfy the Yale observations if a linear formula is used. However a suitable period would throw some of Hertzsprung's[2] observations made in 1924–6 on portions of the light curve where it is doubtful if he could have observed the star as fainter than normal. The residuals under II show that the coefficient of the secular term is too large. A value about half as great would satisfy the later observations

TABLE I. OBSERVATIONS OF FV CARINAE

Julian Day	Ptg. Mag.	Exp. (min.)	Julian Day	Ptg. Mag.	Exp. (min.)
2,429,000+			2,429,000+		
743.272	15.00	16	762.267	15.32	15
743.283	14.65	12	764.243	13.48	6
743.292	14.25	10	764.247	13.58	7
743.300	14.08	8	764.253	13.68	8
743.305	14.0 :	2	764.259	13.75	9
745.257	13.80	5	764.265	13.80	10
745.262	13.80	6	2,430,000+		
745.270	14.02	7	085.314	15.70	20
745.276	14.18	8	085.386	13.62	9
745.282	14.25	10	087.314	13.62	5
745.290	14.55	12	087.319	13.70	5
745.300	14.92	14	087.326	13.78	5
760.199	14.1 :	8	087.335	13.95	6
760.207	13.70	7	087.343	14.20	8
760.212	13.60	6	087.352	14.55	10
760.217	13.50	6	087.361	15.0 :	10
762.196	15.0 :	10	087.369	15.2 :	12
762.204	15.4 :	13	087.379	15.5 :	16

Julian Day	Ptg. Mag.	Exp. (min.)	Julian Day	Ptg. Mag.	Exp. (min.)
2,430,000+			2,430,000+		
102.268	13.78	10	140.233	14.85	18
102.274	13.72	9	501.180	13.70	5
102.281	13.68	9	501.186	13.82	6
102.286	13.62	8	501.192	14.08	8
106.253	13.12	4	501.199	14.38	10
106.265	13.25	5	501.208	14.82	14
106.295	13.40	5	501.220	15.28	20
106.302	13.55	5	518.187	15.4 :	15
106.309	13.58	6	518.197	14.75	12
106.314	13.68	8	877.187	13.92	10
106.319	13.75	8	877.194	13.78	9
106.325	13.78	8	877.200	13.70	8
106.330	13.82	8	877.205	13.62	7
123.215	13.68	5	877.209	13.58	6
123.223	13.90	6	877.213	13.45	5
123.240	14.22	10	877.216	13.42	5
123.250	14.60	15	879.179	15.08	15
123.264	15.20	20			

TABLE II. WEIGHTED MEAN EPOCHS OF MINIMUM

Year	Julian Day of minimum	Epoch	Weight	Residual I	Residual II
1940	2429745.3426	+ 871	8.9	+0.0052	−0.0059
1941	2430087.4051	+1033	8.7	+ .0061	− .0120
1942	2430501.2572	+1229	4.8	+ .0058	− .0223
1943	2430877.1094	+1407	2.0	+ .0125	− .0262