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Period study of the RS CVn eclipsing binary SV Camelopardalis

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Abstract. Using the available photographic and photoelectric times of minima, we have revised the elements of the light-time orbit of SV Camelopardalis, an RS CVn type eclipsing binary. Taking a mass function of 0.118 $M_\odot$ and the inclination of 89°.84 for the eclipsing pair, we obtain the third body mass of 0.18, 0.21 and 0.38 $M_\odot$ for the assumed inclination of the third body orbit of 90°, 60° and 30° respectively.

Key words : eclipsing binary—RS CVn binaries—SV Cam—triple system

1. Introduction

Guthinick (1929) first detected variability of SV Camelopardalis and its eclipsing nature was announced by Detre (1933). Hiltner (1953) studied the spectrum and found a mass function of 0.118 $M_\odot$. Several photometric studies of the system revealed various pecularities, like variations in the light curves, infrared and ultraviolet excesses, radio and x-ray emissions etc. Hall (1976, 1981) classified SV Cam as an RS CVn type binary system. The period variations of the system were found by Pierce (1938), and since then different investigators had analysed these changes. Sommer (1956), fitting the $(O - C)$ curve to a sine wave, found a long period of 57.5 yr. Considering the positions of the secondary minima, which were found to occur at $0^p.5$, Friboes-Conde & Herczeg (1973) ruled out the possibility of apsidal motion being the cause of $(O - C)$ variations and attributed this to the light-time effect of a third body motion. Using the then available times of primary minima and a quadratic ephemeries, they concluded that a light-time orbit is possible and obtained a long period of 72.75 yr and a third body mass function of $f(m_3) =$ 0.00114 $M_\odot$. Later, assuming an eccentric orbit, Hilditch *et al.* (1979), obtained a mass function of the third body, $f(m_3) = 0.00130\ M_\odot$ and a long period of 64.1 yr, and confirmed the reality of a third body in the system.

Considering the large scatter of all visual minima and a few photographic minima, Panchatsaram & Abhyankar (1982) have used only photoelectric minima in their investigation of this system. Assuming a quadratic ephemeris, they have obtained a third body mass function of 0.01580 $M_\odot$ which is very large compared to the previous studies. As this was obtained from statistical consideration, it is not reliable. The recently available photoelectric minima after HJD 244,3263.5948 have suggested that the $(O - C)$ curve is passing through another minimum indicating the completion of nearly one and half cycle in its orbit since the beginning of the available observations. Hence we thought it worthwhile to reanalyse the residuals and determine the elements of the third body in the system.

2. The (O — C) curve

In RS CVn binaries, it is customary to remove the wave and determine the times of minima for period studies (Rao & Sarma 1983). Our preliminary investigation of the light curves of SV Cam published by Patkos (1982) had indicated that the hotter component of the system has a number of short-lived spot groups The wave-removed times of minima turned out to be spurious and have not followed the trend of the earlier observations. Hence we used only uncorrected times of minima in our study of the period variations in SV Cam. All the available times of minima of this system are listed in table 1. Using these times, a least square solution, with unit weight for visual, 3 for photographic and 10 for photoelectric minima, gave the following linear ephemeris :

$$\text{HJD Pri. Min.} : 244{,}2634.3520 + 0^{d}.59307141\ E.$$

$(O - C)$'s calculated from these ephemeris, are given in table 1 under $(O - C)^{\mathrm{I}}$ and are plotted in figure 1. It can be seen from the figure that the residuals have completed nearly one and half cycle and are passing through a minimum. It also indicates an eccentric orbit for the third body.

3. Light-time orbit

Irwin's (1952) method is used for determining the elements of the light-time orbit from the $(O - C)$ *versus* epoch curve. The $(O - C) = 0$ axis is turned in such a way that the amplitudes of the $(O - C)$ variation on either side are rendered equal as shown in figure 1. The new $(O - C) = 0$ axis, which is shown as dashed line in figure 1, corresponds to a period of $0^{d}.593071794$ which is the true period of the eclipsing pair. The $(O - C)$'s obtained from the new ephemeris

$$\text{HJD Pri. Min.} = 244{,}2634.3562 + 0^{d}.593071794\ E$$

are also given in table 1 under $(O - C)^{\mathrm{II}}$ and are plotted in figure 2.

The light-time effect τ which is the value of $(O - C)$ for the ephemeris corresponding to the centre of mass of the system is given by Irwin (1952) as

$$\tau = \frac{k}{\sqrt{1 - e^2 \cos^2 \omega}} \left\{ \frac{1 - e^2}{1 + e \cos v} \sin (v + \omega) + e \sin \omega \right\} \qquad \ldots(1)$$

where

$$k = \frac{\tau_{max} - \tau_{min}}{2} = \frac{a \sin i \sqrt{1 - e^2 \cos^2 \omega}}{2.59 \times 10^{10}}. \qquad \ldots(2)$$

Table 1. SV Cam : Times of primary minima

HJD			E	$(O-C)^{I}$	$(O-C)^{II}$	Ref.
241	7501.7660	PG	−42377.	.0010	.0132	1
	8498.1180	PG	−40697.	−.0070	.0046	1
	9500.4140	PG	−39007.	−.0017	.0093	1
242	0496.7660	PG	−37327.	−.0096	.0007	1
	1499.0570	PG	−35637.	−.0093	.0003	1
	2501.3460	PG	−33947.	−.0110	−.0020	1
	3497.7010	PG	−32267.	−.0159	−.0076	1
	4499.9930	PG	−30577.	−.0146	−.0070	1
	5549.7270	PG	−28807.	−.0170	−.0100	1
	5951.2490	PG	−28130.	−.0043	.0024	2
	6420.3540	V	−27339.	−.0188	−.0124	3
	6433.4080	V	−27317.	−.0124	−.0060	4
	6439.3420	V	−27307.	−.0091	−.0027	3
	6498.6460	PG	−27207.	−.0123	−.0059	1
	6513.4750	V	−27182.	−.0100	−.0037	3
	6618.4470	V	−27005.	−.0117	−.0054	3
	6799.3330	PG	−26700.	−.0125	−.0063	2
	6933.3660	V	−26474.	−.0136	−.0075	5
	6946.4100	V	−26452.	−.0172	−.0111	5
	6949.3740	V	−26447.	−.0185	−.0125	5
	6968.3520	V	−26415.	−.0188	−.0128	5
	6980.2170	V	−26395.	−.0152	−.0092	5
	7003.3450	V	−26356.	−.0170	−.0110	5
	7134.4120	V	−26135.	−.0188	−.0129	5
	7447.5560	PG	−25607.	−.0165	−.0108	1
	8132.5650	V	−24452.	−.0040	.0013	6
	8148.5750	V	−24425.	−.0079	−.0026	6
	8196.6160	V	−24344.	−.0057	−.0004	6
	8209.6610	V	−24322.	−.0083	−.0030	6
	8301.5860	PG	−24167.	−.0093	−.0042	1
	8563.7250	V	−23725.	−.0079	−.0029	6
	8610.5770	V	−23646.	−.0085	−.0036	6
	8862.6350	V	−23221.	−.0059	−.0011	7
	9172.2220	PG	−22699.	−.0022	.0025	8
	9174.5920	V	−22695.	−.0044	.0002	7
	9176.3720	PG	−22692.	−.0037	.0009	8
	9177.5640	PG	−22690.	.0022	.0068	8
	9183.4950	PG	−22680.	.0025	.0071	8
	9277.7850	PG	−22521.	−.0059	−.0013	9
	9286.6810	PG	−22506.	−.0059	−.0014	9
	9287.8700	PG	−22504.	−.0031	.0015	9
	6487.3778	V	−27226.	−.0121	−.0057	29
	6939.8873	V	−26463.	−.0161	−.0100	29
	7290.9840	V	−25871.	−.0177	−.0118	29
	8197.8005	V	−24342.	−.0073	−.0021	29
	8678.7813	V	−23531.	−.0074	−.0025	29
	9217.2950	V	−22623.	−.0026	.0020	29
243	1745.5660	V	−18360.	.0050	.0079	9
	2253.8190	PE	−17503.	−.0042	−.0016	10
	2265.6819	PE	−17483.	−.0027	−.0001	10
	2268.6483	PE	−17478.	−.0017	.0009	10
	2281.6963	PE	−17456.	−.0012	.0013	10
	2287.6263	PE	−17446.	−.0020	.0006	10
	2878.9214	PE	−16449.	.0010	.0031	10
	2883.6648	PE	−16441.	−.0002	.0020	10

Continued

Table 1—*Continued*

HJD		E	$(O-C)^{I}$	$(O-C)^{II}$	Ref.
243 2911.5381	PE	−16394.	−.0013	.0009	10
2949.4949	PE	−16330.	−.0010	.0011	10
3179.6094	PE	−15942.	.0018	.0037	10
3180.7937	PE	−15940.	−.0001	.0019	10
3183.7583	PE	−15935.	−.0008	.0011	10
3314.8284	PE	−15714.	.0005	.0024	19
3433.4530	V	−15514.	.0108	.0126	10
3433.4510	V	−15514.	.0088	.0106	10
3433.4490	V	−15514.	.0068	.0086	10
3436.4090	V	−15509.	.0014	.0033	10
3436.4120	V	−15509.	.0044	.0063	10
3541.3790	V	−15332.	−.0022	−.0005	10
3541.3790	V	−15332.	−.0022	−.0005	10
3541.3830	V	−15332.	.0018	.0035	10
3544.3560	V	−15327.	.0094	.0112	10
3544.3460	V	−15327.	−.0006	.0012	10
3544.3450	V	−15327.	−.0016	.0002	10
3649.3320	V	−15150.	.0118	.0135	10
3703.3000	V	−15059.	.0103	.0119	10
3719.3100	V	−15032.	.0074	.0090	10
3745.4080	V	−14988.	.0102	.0118	10
3745.3990	V	−14988.	.0012	.0028	10
4121.4070	V	−14354.	.0020	.0033	10
4134.4540	V	−14332.	.0014	.0028	10
4169.4460	V	−14273.	.0022	.0035	10
4169.4460	V	−14273.	.0022	.0035	10
4201.4710	V	−14219.	.0013	.0026	10
4358.6360	V	−13954.	.0024	.0036	10
4422.6880	V	−13846.	.0027	.0039	10
4439.2940	V	−13818.	.0027	.0038	10
4452.3410	V	−13796.	.0021	.0033	10
4452.3410	V	−13796.	.0021	.0033	10
4455.3070	V	−13791.	.0028	.0039	10
4457.6790	V	−13787.	.0025	.0036	10
4605.3540	V	−13538.	.0027	.0037	10
4676.5230	V	−13418.	.0031	.0041	10
4780.3100	V	−13243.	.0026	.0036	10
4844.3620	V	−13135.	.0029	.0038	10
4941.6260	V	−12971.	.0032	.0040	10
4951.7080	V	−12954.	.0030	.0038	10
5246.4660	V	−12457.	.0045	.0051	10
5246.4660	V	−12457.	.0045	.0051	10
5303.4010	V	−12361.	.0046	.0052	10
5303.4010	V	−12361.	.0046	.0052	10
5332.4610	V	−12312.	.0042	.0047	10
5332.4610	V	−12312.	.0042	.0047	10
5370.4180	V	−12248.	.0046	.0051	10
5379.3140	V	−12233.	.0045	.0051	10
3568.6687	V	−15286.	.0062	.0079	11
3741.8398	PE	−14994.	.0005	.0021	10
3741.8405	PE	−14994.	.0012	.0028	10
3761.4114	PE	−14961.	.0007	.0023	10
3762.5979	PE	−14959.	.0011	.0027	10
3768.5288	PE	−14949.	.0012	.0028	10
3769.7144	PE	−14947.	.0007	.0023	10

Continued

Table 1—*Continued*

HJD		E	$(O-C)^{I}$	$(O-C)^{II}$	Ref.
243 3769.7159	PE	−14947.	.0022	.0038	10
3769.7174	PF	−14947.	.0037	.0053	10
3775.6465	PE	−14937.	.0021	.0037	10
3775.6470	PE	−14937.	.0026	.0042	10
3777.4241	PE	−14934.	.0005	.0021	10
3784.5405	PE	−14922.	.0000	.0016	10
3791.6579	PE	−14910.	.0006	.0021	10
3791.6582	PE	−14910.	.0009	.0024	10
3803.5200	PE	−14890.	.0012	.0028	10
3844.4420	PE	−14821.	.0013	.0029	10
3895.4451	PE	−14735.	.0003	.0018	10
3911.4575	PE	−14708.	−.0003	.0012	10
3921.5415	PE	−14691.	.0015	.0030	10
3923.3209	PE	−14688.	.0017	.0032	10
3227.4731	PE	−14681.	.0024	.0039	10
3928.6591	PE	−14679.	.0023	.0038	10
3931.6243	PE	−14674.	.0021	.0036	10
3943.4847	PE	−14654.	.0011	.0026	10
4159.3707	PG	−14290.	.0091	.0104	29
4423.2867	V	−13845.	.0083	.0095	11
4602.9858	PG	−13542.	.0068	.0078	29
5309.3356	V	−12351.	.0085	.0091	11
5311.7085	PG	−12347.	.0091	.0097	29
5999.0763	V	−11188.	.0072	.0073	11
6636.0337	V	−10114.	.0059	.0056	11
7027.4550	PG	−9454.	.0001	−.0005	19
7027.4580	PG	−9454.	.0031	.0025	19
7027.4610	V	−9454.	.0061	.0055	19
7189.3710	V	−9181.	.0076	.0069	19
7364.3320	V	−8886.	.0125	.0118	19
7559.4450	V	−8557.	.0050	.0041	19
7559.4480	V	−8557.	.0080	.0071	19
7587.3200	V	−8510.	.0057	.0048	19
7603.3310	V	−8483.	.0037	.0028	19
7603.3330	V	−8483.	.0057	.0048	19
7651.3780	V	−8402.	.0120	.0110	19
7651.3790	V	−8402.	.0130	.0120	19
7667.3800	V	−8375.	.0010	.0001	19
7667.3820	V	−8375.	.0030	.0021	19
7667.3880	V	−8375.	.0090	.0081	19
7696.4500	V	−8326.	.0105	.0096	19
7678.6530	V	−8356.	.0057	.0047	11
7696.4520	V	−8326.	.0125	.0116	19
7705.3460	V	−8311.	.0105	.0095	19
7731.4310	V	−8267.	.0003	−.0007	19
7731.4360	V	−8267.	.0053	.0043	19
7737.3530	V	−8257.	−.0084	−.0094	19
7737.3500	V	−8257.	−.0114	−.0124	19
7766.4300	V	−8208.	.0081	.0071	19
7766.4310	V	−8208.	.0091	.0081	19
7785.4020	V	−8176.	.0018	.0008	19
7903.4260	V	−7977.	.0046	.0035	19
7922.3950	V	−7945.	−.0047	−.0058	19
7928.3250	V	−7935.	−.0054	−.0065	19
7944.3460	V	−7908.	.0027	.0015	19

Continued

Table 1—*Continued*

HJD		*E*	$(O-C)^{I}$	$(O-C)^{II}$	Ref.
243 7944.3480	V	−7908.	.0047	.0035	19
7947.3100	V	−7903.	.0013	.0002	19
7947.3110	V	−7903.	.0023	.0012	19
7958.5820	V	−7884.	.0050	.0038	19
7958.5830	V	−7884.	.0060	.0048	19
7958.5850	V	−7884.	.0080	.0068	19
7958.5880	V	−7884.	.0110	.0098	19
8041.0111	V	−7745.	−.0029	−.0041	1
7354.8280	V	−8902.	−.0023	−.0031	29
7864.8690	V	−8042.	−.0028	−.0038	29
8001.2820	V	−7812.	.0038	.0027	19
8001.2830	V	−7812.	.0048	.0037	19
8049.3260	V	−7731.	.0090	.0078	19
8091.4350	V	−7660.	.0100	.0087	19
8091.4360	V	−7660.	.0110	.0097	19
8180.3910	V	−7510.	.0053	.0040	19
8180.3940	V	−7510.	.0083	.0070	19
8238.5080	V	−7412.	.0013	−.0001	19
8244.4350	V	−7402.	−.0025	−.0038	19
8335.1750	V	−7249.	−.0024	−.0038	29
8371.3730	V	−7188.	.0183	.0169	19
8371.3680	V	−7188.	.0133	.0119	19
8371.3630	V	−7188.	.0083	.0069	19
8413.4750	V	−7117.	.0122	.0108	19
8499.4700	V	−6972.	.0118	.0103	19
8500.6510	V	−6970.	.0067	.0052	1
8502.4060	V	−6967.	−.0175	−.0190	19
8502.4120	V	−6967.	−.0115	−.0130	19
8502.4140	V	−6967.	−.0095	−.0110	19
8502.4160	V	−6967.	−.0075	−.0090	19
7502.4200	V	−6967.	−.0035	−.0050	19
8513.7050	V	−6948.	.0131	.0116	19
8525.5490	V	−6928.	−.0043	−.0058	19
8561.7430	V	−6867.	.0123	.0108	19
8583.6840	V	−6830.	.0097	.0082	19
8607.4080	V	−6790.	.0108	.0093	19
8603.8370	V	−6796.	−.0017	−.0033	29
8652.4790	PE	−6714.	.0084	.0068	12
8667.3120	PE	−6689.	.0146	.0130	12
8667.9011	V	−6688.	.0107	.0091	13
8671.4600	PE	−6682.	.0111	.0095	12
8672.6510	V	−6680.	.0160	.0144	19
8691.6220	V	−6648.	.0087	.0071	19
8694.5760	V	−6643.	−.0026	−.0043	29
8694.5900	V	−6643.	.0114	.0097	19
8709.4000	V	−6618.	−.0054	−.0071	19
8713.5710	V	−6611.	.0141	.0124	19
8723.6490	V	−6594.	.0099	.0082	19
8726.6100	V	−6589.	.0055	.0039	19
8726.6190	V	−6589.	.0145	.0129	19
8780.5780	V	−6498.	.0040	.0023	19
8796.6000	V	−6471.	.0131	.0114	19
8817.3500	V	−6436.	.0056	.0039	19
8833.3570	V	−6409.	−.0004	−.0021	19

Continued

Table 1—*Continued*

HJD			*E*	$(O-C)^{I}$	$(O-C)^{II}$	Ref.
243	8833.3610	V	−6409.	.0036	.0019	19
	8833.3630	V	−6409.	.0056	.0039	19
	8833.3640	V	−6409.	.0066	.0049	19
	8892.6650	V	−6309.	.0005	−.0013	19
	8910.4600	V	−6279.	.0034	.0016	19
	8910.4650	V	−6279.	.0084	.0066	19
	8927.6730	V	−6250.	.0173	.0155	19
	8947.8360	V	−6216.	.0159	.0141	19
	8977.4810	V	−6166.	.0073	.0055	19
	8997.6520	V	−6132.	.0139	.0120	19
	8972.7380	V	−6174.	.0089	.0071	19
	8918.1729	V	−6266.	.0063	.0046	11
	8991.1120	V	−6143.	−.0024	−.0042	29
	9027.2980	V	−6082.	.0063	.0045	19
	9036.7790	V	−6066.	−.0019	−.0037	29
	9036.7940	V	−6066.	.0131	.0113	19
	9634.5950	V	−5058.	−.0018	−.0041	19
	9040.3560	V	−6060.	.0167	.0149	13
	9040.9414	V	−6059.	.0090	.0072	1
	9050.4190	V	−6043.	−.0025	−.0043	19
	9077.7120	V	−5997.	.0092	.0073	19
	9080.6800	V	−5992.	.0119	.0100	19
	9091.3470	V	−5974.	.0036	.0017	19
	9091.3490	V	−5974.	.0056	.0037	19
	9091.3500	V	−5974.	.0066	.0047	19
	9091.3520	V	−5974.	.0086	.0067	19
	9228.3510	V	−5743.	.0081	.0061	19
	9228.3520	V	−5743.	.0091	.0071	19
	9406.2730	V	=5443.	.0087	.0066	19
	9406.2760	V	−5443.	.0117	.0096	19
	9416.3410	V	−5426.	−.0056	−.0076	19
	9416.3390	V	−5426.	−.0076	−.0096	19
	9227.1677	V	−5745.	.0109	.0090	14
	9367.7202	V	−5508.	.0055	.0034	13
	9652.9875	V	−5027.	.0055	.0032	13
	9681.4567	PE	−4979.	.0072	.0050	15
	9776.3460	PE	−4819.	.0051	.0028	15
	9820.2400	V	−4745.	.0118	.0029	19
	9826.7579	V	−4734.	.0059	.0036	13
	9932.9192	V	−4555.	.0075	.0050	13
	9945.3718	PE	−4534.	.0056	.0031	16
	9977.3980	PE	−4480.	.0059	.0034	16
	9987.4810	V	−4463.	.0067	.0042	19
	9990.4480	V	−4458.	.0083	.0059	19
	9999.9400	V	−4442.	.0112	.0087	14
244	0019.5120	V	−4409.	.0118	.0093	19
	35.5240	V	−4382.	.0109	.0084	19
	38.4890	V	−4377.	.0105	.0080	19
	60.4350	V	−4340.	.0129	.0104	19
	63.4100	V	−4335.	.0225	.0200	19
	73.4800	V	−4318.	.0103	.0078	19
	73.4830	V	−4318.	.0133	.0108	19
	92.4550	V	−4286.	.0070	.0045	19
	92.4561	PE	−4286.	.0081	.0056	16
	95.4300	V	−4281.	.0167	.0142	19

Continued

Table 1—*Continued*

HJD		E	$(O-C)^{I}$	$(O-C)^{II}$	Ref.
244 0101.3440	V	−4271.	.0000	−.0026	19
101.3570	V	−4271.	.0130	.0104	19
127.4466	PE	−4227.	.0074	.0049	16
142.2740	V	−4202.	.0080	.0055	19
148.2049	V	−4192.	.0082	.0057	13
194.4540	V	−4114.	−.0022	−.0048	29
276.3130	V	−3976.	.0129	.0103	19
276.3220	V	−3976.	.0219	.0193	19
289.3490	V	−3954.	.0013	−.0013	19
289.3580	V	−3954.	.0103	.0077	19
290.5360	V	−3952.	.0022	−.0005	19
318.4100	V	−3905.	.0018	−.0008	19
321.3760	V	−3900.	.0025	−.0002	19
321.3770	V	−3900.	.0035	.0008	19
337.3780	V	−3873.	−.0084	−.0111	19
344.5100	V	−3861.	.0067	.0010	19
353.3970	V	−3846.	−.0024	−.0051	19
354.5850	V	−3844.	−.0005	−.0032	19
477.3340	V	−3637.	−.0173	−.0201	19
477.3520	V	−3637.	.0007	−.0021	19
515.3180	V	−3573.	.0101	.0073	19
383.6530	V	−3795.	.0070	.0043	13
418.6430	V	−3736.	.0031	.0003	13
528.3540	V	−3551.	−.0014	−.0043	14
528.3615	PE	−3551.	.0061	.0032	17
593.5983	PE	−3441.	.0050	.0021	26
631.5460	V	−3377.	−.0039	−.0068	19
638.0720	V	−3366.	−.0016	−.0045	29
646.3810	V	−3352.	.0044	.0015	19
652.3110	V	−3342.	.0036	.0007	19
655.2810	V	−3337.	.0083	.0054	19
720.5140	V	−3227.	.0034	.0005	19
774.4800	V	−3136.	−.0001	−.0031	19
780.4210	V	−3126.	.0102	.0072	19
796.4310	V	−3099.	.0073	.0043	19
812.4400	V	−3072.	.0034	.0004	19
829.0453	V	−3044.	.0027	−.0004	14
837.3470	V	−3030.	.0014	−.0017	19
837.3490	V	−3030.	.0034	.0003	19
844.4540	V	−3018.	−.0085	−.0115	19
850.3960	V	−3008.	.0028	−.0002	19
853.3560	V	−3003.	−.0026	−.0056	19
853.3570	V	−3003.	−.0016	−.0046	19
854.5530	V	−3001.	.0083	.0053	19
855.7333	V	−2999.	.0024	−.0006	13
857.5139	PE	−2996.	.0038	.0008	18
872.3390	V	−2971.	.0021	−.0009	19
872.3440	V	−2971.	.0071	.0041	19
878.2700	V	−2961.	.0024	−.0006	19
900.2090	V	−2924.	−.0022	−.0053	29
939.3520	V	−2858.	−.0019	−.0050	19
964.2670	V	−2816.	.0041	0010	19
964.2700	V	−2816.	.0071	.0040	19
964.2700	V	−2816.	.0071	.0040	19
987.3990	V	−2777.	.0063	.0032	19

Continued

Table 1—*Continued*

HJD		E	$(O-C)^{I}$	$(O-C)^{II}$	Ref.
244 0993.3310	V	−2767.	.0076	.0045	19
1028.3170	V	−2708.	.0024	−.0008	19
1049.6700	V	−2672.	.0048	.0016	14
1341.4602	V	−2180.	.0039	.0005	14
1506.9241	V	−1901.	.0008	−.0026	13
1357.4620	V	−2153.	−.0073	−.0106	29
1681.2879	V	−1607.	.0016	−.0019	20
1709.1596	V	−1560.	−.0010	−.0046	14
2037.7216	V	−1006.	−.0006	−.0044	14
2071.5288	V	−949.	.0016	−.0023	13
2241.7329	V	−662.	−.0058	−.0098	14
2366.2810	PE	−452.	−.0027	−.0067	21
2407.7975	V	−382.	−.0012	−.0053	14
2467.1041	V	−282.	−.0018	−.0059	13
2517.5142	PE	−197.	−.0027	−.0069	22
2545.3909	PE	−150.	−.0004	−.0045	22
2545.3895	V	−150.	−.0018	−.0059	22
2572.0769	V	−105.	−.0026	−.0068	14
2690.1020	V	94.	.0013	−.0029	13
2771.3500	PE	231.	−.0015	−.0058	22
2777.2786	PE	241.	−.0036	−.0079	22
2777.2792	PE	241.	−.0030	−.0073	19
2836.5985	PE	341.	.0012	−.0032	23
2852.6010	PE	368.	−.0013	−.0056	23
2855.5658	PE	373.	−.0018	−.0062	23
2872.7636	V	402.	−.0031	−.0075	14
3115.3310	PE	811.	−.0019	−.0064	26
3118.2948	V	816.	−.0035	−.0080	14
3138.4610	PE	850.	−.0017	−.0062	24
3263.5948	PE	1061.	−.0060	−.0106	27
3497.8620	V	1456.	−.0020	−.0067	14
3855.4801	V	2059.	−.0059	−.0109	14
1695.5194	PE	−1583.	−.0006	−.0042	28
1697.2980	PE	−1580.	−.0012	−.0048	28
1905.4670	PE	−1229.	−.0002	−.0040	28
1930.3770	PE	−1187.	.0008	−.0030	28
1931.5635	PE	−1185.	.0011	−.0026	28
1933.3437	PE	−1182.	.0021	−.0016	28
1934.5278	PE	−1180.	.0001	−.0037	28
1959.4370	PE	−1138.	.0003	−.0035	28
1960.6230	PE	−1136.	.0001	−.0036	28
1962.4024	PE	−1133.	.0003	−.0035	28
1978.4160	PE	−1106.	.0010	−.0028	28
1981.3800	PE	−1101.	−.0004	−.0042	28
1982.5665	PE	−1099.	−.0000	−.0038	28
1984.3449	PE	−1096.	−.0008	−.0046	28
2019.3347	PE	−1037.	−.0023	−.0060	28
2106.5154	PE	−890.	−.0030	−.0069	28
2304.6040	PE	−556.	−.0003	−.0043	28
2405.4243	PE	−386.	−.0021	−.0062	28
2460.5805	PE	−293.	−.0016	−.0057	28
2465.3249	PE	−285.	−.0017	−.0058	28
2523.4453	PE	−187.	−.0023	−.0065	28
2545.3880	PE	−150.	−.0033	− 0074	28
2603.5100	PE	−52.	−.0023	−.0065	28

Continued

Table 1—*Continued*

HJD		E	$(O-C)^{I}$	$(O-C)^{II}$	Ref.
244 2634.3500	PE	0.	−.0020	−.0062	28
2829.4700	PE	329.	−.0025	−.0068	28
2830.6550	PE	331.	−.0036	−.0080	28
2836.5850	PE	341.	−.0043	−.0087	28
2871.5780	PE	400.	−.0026	−.0069	28
3061.3603	PE	720.	−.0031	−.0076	28
3077.3740	PE	747.	−.0023	−.0068	28
3078.5608	PE	749.	−.0017	−.0062	28
3135.4945	PE	845.	−.0028	−.0074	28
3192.4293	PE	941.	−.0029	−.0075	28
3198.3599	PE	951.	−.0030	−.0076	28
3218.5236	PE	985.	−.0037	−.0083	28
3393.4808	PE	1280.	−.0026	−.0073	28
3849.5518	PE	2049.	−.0035	−.0085	28
3878.6130	PE	2098.	−.0028	−.0078	28
3880.3930	PE	2101.	−.0020	−.0070	28
3928.4300	PE	2182.	−.0038	−.0089	28
4049.4184	PE	2386.	−.0020	−.0071	28
4103.3850	PE	2477.	−.0049	−.0100	28
4285.4614	PE	2784.	−.0014	−.0067	28
4345.3617	PE	2885.	−.0013	−.0066	28
4371.4559	PE	2929.	−.0022	−.0076	28
4454.4869	PE	3069.	−.0012	−.0066	28
4582.5892	PE	3285.	−.0024	−.0078	28
5627.5844	PE	5047.	.0010	−.0051	29
5658.4215	PE	5099.	−.0016	−.0078	29
5696.3782	PE	5163.	−.0015	−.0077	29
5741.4540	PE	5239.	.0009	−.0053	29

V = Visual, PG = Photographic, PE = Photoelectric, $(O-C)^{I}$ refer to the ephemeris : 244,2634.3520 + $0^{d}.593071410$ E, $(O-C)^{II}$ refer to the ephemeris : 244,2634.3562 + $0^{d}.593071794$ E

References : 1. Dugan *et al.* (1939); 2. Miczaika (1936); 3. Theile (1934); 4. Beyer (1936) 5. Dunst (1933); 6. Pierce (1938); 7. Pierce (1939); 8. Nekrasova (1945); 9. Wood (1946); 10. Van Woerden (1957); 11. Hall & Kreiner (1980); 12. Pohl & Kizilirmak (1966); 13. Hall & Kreiner (1980); 14. Hall & Kreiner (1980); 15. Kizilirmak & Pohl (1969); 16. Pohl & Kizilirmak (1970); 17. Muthsam (1972); 18. Kizilirmak & Pohl (1971); 19. Friboes-Conde & Herczeg (1973); 20. Kizilirmak & Pohl (1974); 21. Pohl & Kizilirmak (1975); 22. Pohl & Kizilirmak (1976); 23. Mallama *et al.* (1977); 24. Pohl & Kizilirmak (1977); 25. Budding *et al.* (1977); 26. Hilditch *et al.* (1979); 27. Mallama (1979); 28. Patkos (1982); 29. Cellino *et al,* (1984).

is the semiamplitude of $(O-C)$ variation. τ is in days and a, the semimajor axis of the light-time orbit, is in kilometers; e is eccentricity, and ω the longitude of periastron, and v the true anomoly. From figure 2, we have obtained the following elements :

$K = 0^{d}.0079$

$P = 54.23$ yr

T (time of periastron) = HJD 242,1283.7716.

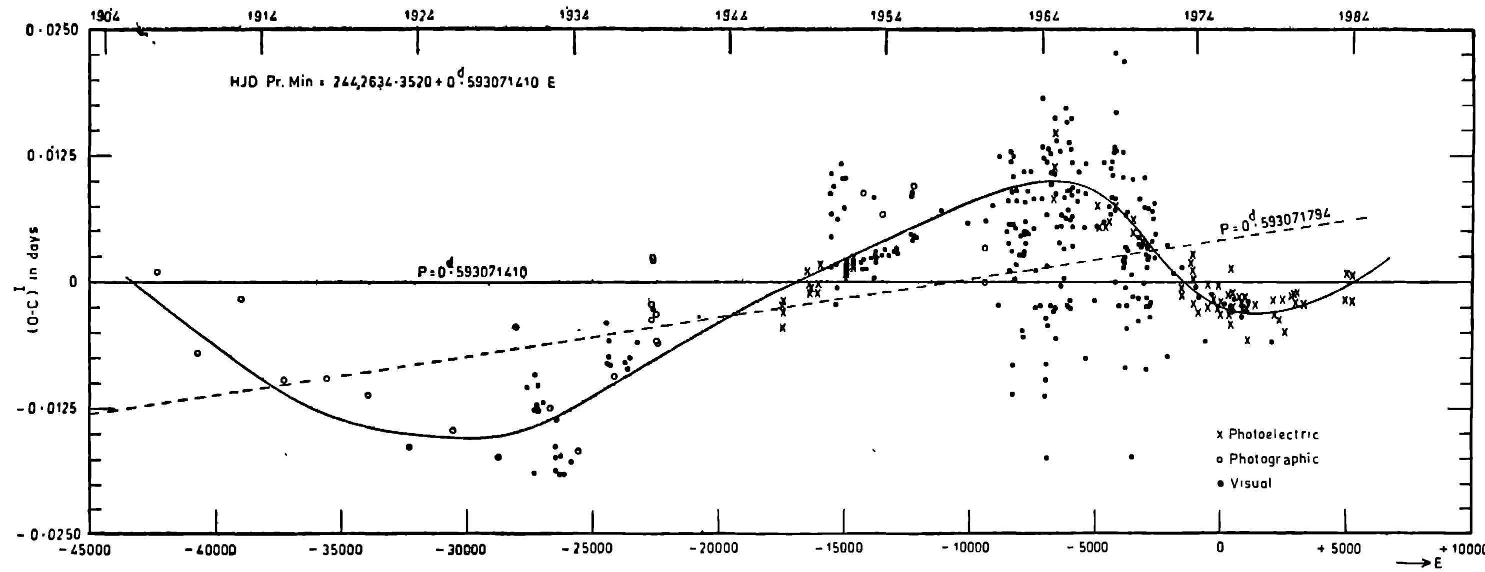

Figure 1. SV Cam. : $(O - C)$ curve obtained using the ephemeris :
HJD Pri. Min. : 244, 2634.3520 + $0^{d}.59307141$ E. See text for details.

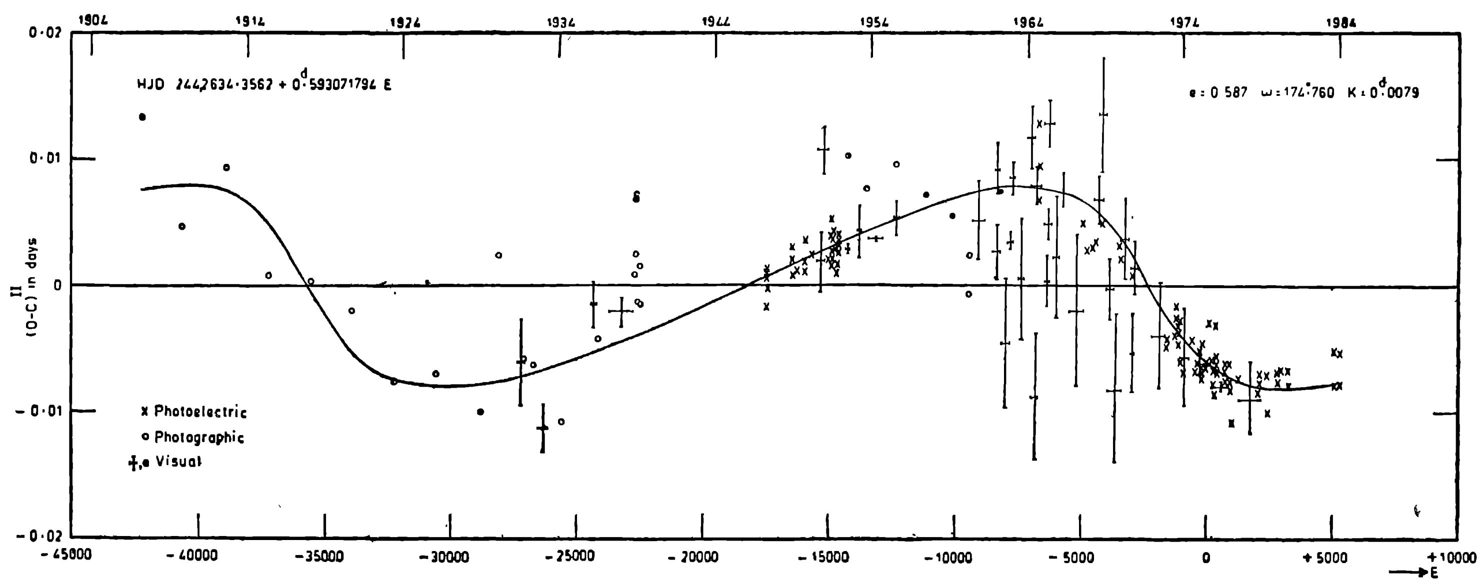

Figure 2. SV Cam : The new $(O - C)$ diagram. The continuous line represents the theoretical curve obtained with the adopted third body orbital elements and the ephemeris :
HJD Pri. Min. : 244, 2634.3562 + $0^{d}.593071794$ E. See text for details.

With the aid of (e, ω) tables of Irwin (1952) and his graphical method, preliminary values of e and ω are calculated as

$$e = 0.478$$

$$\omega = 167^\circ.590.$$

All these elements P, K, T, e and ω can be corrected by the least square method. As it was felt that only e and ω needed correction, they were corrected by a least square method with the following weights. The photographic minima were given unit weight while the photoelectric minima were given a weight of 10. Since the visual observations have large scatter, they are not included in the analysis.

The corrections to e and ω were found to be 0.1087 ± 0.027 and $7^\circ.1697 \pm 2^\circ.4$ respectively thus giving the corrected elements as

$$e = 0.587 \pm 0.027 \text{ (s.e.)}$$

$$\omega = 174^\circ.760 \pm 2^\circ.4 \text{ (s.e.)}.$$

From these elements, using equation (2), $a \sin i$ was calculated to be 2.52×10^8 km. A theoretical curve was computed with these elements and is shown in figure 2, as solid line. Open circles in the figure denote photographic minima, and crosses the photoelectric minima. The means of visual observations, with standard errors as indicated by bars, are also shown for comparison. The fit of the residuals to the theoretical curve is seen to be satisfactory. The corresponding mass function is $f(m) = 0.001625\ M_\odot$. This value is in good agreement with that of Hilditch *et al.* (1979) but slightly larger than that of Friboes-Conde & Herczeg (1973).

4. Discussion

Our preliminary study of the photoelectric light curves of SV Cam from the published data of Patkos (1982) gives a spectral type of G 2–3 V for the primary and K 4 V for the secondary (assuming no space reddening) and a value of $89^\circ.94$ for the inclination of the eclipsing pair. Assuming the components to be normal, the mass of the primary comes out to be about one solar mass and that of the secondary to be about 0.7 $M_\odot$ (Allen 1976), thus giving the total mass of the binary to be 1.7 $M_\odot$. These masses give a photometric mass function of 0.119 $M_\odot$, which agrees quite well with the spectroscopic mass function of 0.118 $M_\odot$ given by Hiltner (1953). Using the value of 1.7 $M_\odot$ as the total mass of the binary system in the mass function of the triple system, we obtain the mass of the third body as 0.18, 0.21 and 0.38 $M_\odot$ for $i = 90$, 60 and 30 degrees respectively. These masses are too small to enable spectroscopic and photometric detection. We feel that the presence of a third body in the system SV Cam is now well established and further observations of the times of minima are needed for a more precise determination of the elements.

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