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A STUDY OF THE NON-ECLIPSING BINARY SV GEMINORUM

GUILBAULT, PETER R.[1]; LLOYD, CHRISTOPHER[2]; PASCHKE, ANTON[3]

[1] P.O. Box 287,Chepachet,Rhode Island 02814, USA, e-mail: pete1199@aol.com

[2] Space Science & Technology Department, Rutherford Appleton Laboratory, Oxfordshire, UK, e-mail: cl@astro1.bnsc.rl.ac.uk

[3] Rüti, Switzerland, e-mail:Anton_Paschke@swissre.com

SV Geminorum = GSC 1868.0220 = HIP 28472 = HV 3093 is located at $06^{\rm h}00^{\rm m}41\overset{\rm s}{.}01$, $+24°28'26\overset{''}{.}06$ (J2000). In the GCVS (Kholopov et al. 1985) the star is classified as an Algol-type (EA/SD) eclipsing variable that fades from a maximum of $m_{\rm v} = 10.55$ to $m_{\rm pg} = 12.0$ at primary minimum, where $m_{\rm v}$ are photovisual (yellow sensitive) magnitudes, and $m_{\rm pg}$ are photographic (blue sensitive) magnitudes. Variability was discovered by Cannon and announced by Pickering (1908). A period could not be determined at the time of discovery. Enebo (1910) determined a preliminary period in 1909 and followup observations by Enebo (1913) yielded the improved light elements: $2418662.46 + 4\overset{\rm d}{.}00604 \times E$. The star was later studied by the Milton Bureau at the Harvard College Observatory and the period was revised by Woodward (1943) to $4\overset{\rm d}{.}0061216$, who noted that "Minima seem shallow in recent years". Whitney (1959) examined 173 photographic plates exposed between 1953 and 1958 which "show no certain indication of an eclipse". A preliminary investigation by Guilbault of the photographic plate collection at Harvard revealed that eclipses in the early 1900's were 1.0 mag or greater in depth, but did, in fact, appear more shallow by 1920.

The only radial velocity curve of SV Gem is by Struve (1945) who found an eccentricity of 0.16. Unfortunately the velocity curve is noisy and poorly sampled, and the solution was redetermined as circular in Lucy and Sweeney's (1971) large re-evaluation of orbits with small eccentricities. For further details see the discussion in Batten et al.'s (1989) Eighth Catalogue. Struve gives the spectral type as B3 or possible B2.

A search of the literature has failed to find any subsequent study which explores the long-term light behavior of SV Gem in detail. For that reason we decided to conduct an extensive survey of the archival photographic plate collection at Harvard to record the changing light curve amplitude of this unusual star over the last 100 years.

1002 blue sensitive plates from the AC Patrol Series, RH Patrol Series, and the Damon Patrol Series were examined. Coverage is continuous from 1894–1989, except a twenty year gap (1953–1972) when no exposures were taken at Harvard. Magnitude estimates were made by eye, using a comparison star sequence taken from the USNO-A2.0 catalogue (Monet et al. 1998). At maximum light the star was judged to be $m_{\rm pg} = 11.2$, and the accuracy of the plate estimates is about $\pm 0\overset{\rm m}{.}1$.

A summary of our results is shown in Table 1. The duration of the eclipse of SV Gem is 0.15 the orbital period, or 14.4 hours. The time of each dimming is the midpoint

of the exposure, generally one hour in duration, and therefore in some cases may not represent the absolute minimum attained. The epoch, $O-C$ and phase values were calculated using the elements $2418662.488 + 4^{\rm d}.0061216 \times E$ (Woodward 1943). So that the changes in the amplitude of the eclipse may be readily seen, the magnitude estimate for each observation is listed in the last column. All our photographic data are available electronically as 5090-t2.txt through the IBVS Web site.

Table 1: Harvard plate observations at minimum light, SV Geminorum

HJD 2400000 +	Year	Epoch	$O-C$	Phase	$m_{\rm pg}$
15429.571	1901	−807	+0.023	0.006	12.7
15665.778	1901	−748	−0.131	0.967	11.6
16138.691	1903	−630	+0.060	0.015	12.4
16146.613	1903	−628	−0.030	0.992	12.0
16158.534	1903	−625	−0.128	0.968	11.8
16166.593	1903	−623	−0.002	0.979	<12.0
16174.620	1903	−621	−0.066	0.983	12.0
16222.557	1903	−609	−0.202	0.949	11.5
16358.886	1903	−575	−0.082	0.980	12.1
16382.866	1903	−569	−0.138	0.965	12.2
16799.707	1904	−465	+0.066	0.016	12.0
16823.727	1904	−459	+0.049	0.012	12.0
16839.718	1904	−455	+0.015	0.004	11.8
16843.767	1904	−454	+0.058	0.015	12.2
16915.581	1904	−436	−0.237	0.941	11.5
17496.794	1906	−291	+0.087	0.022	12.2
17528.776	1906	−283	+0.020	0.005	12.6
17552.755	1906	−277	−0.037	0.991	12.7
17977.599	1908	−171	+0.158	0.039	11.5
18209.819	1908	−113	+0.023	0.006	<11.5
18245.781	1908	−104	−0.070	0.982	11.9
18297.823	1908	−91	−0.107	0.973	11.8
18662.682	1909	0	+0.194	0.048	11.5:
18742.523	1910	+20	−0.087	0.978	12.3
18962.820	1910	+75	−0.127	0.968	11.4
19443.542	1912	+195	−0.140	0.965	11.8
20092.790	1913	+357	+0.117	0.029	11.5
20805.815	1915	+535	+0.052	0.013	11.4
20809.836	1915	+536	+0.067	0.017	11.5
20877.649	1916	+553	−0.224	0.944	11.4
21310.610	1917	+661	+0.075	0.019	11.5
21558.822	1917	+723	−0.091	0.977	11.8
21979.615	1919	+828	+0.058	0.015	11.6
22692.743	1921	+1006	+0.096	0.024	11.4
26706.728	1931	+2008	−0.052	0.979	11.5
28096.878	1935	+2355	−0.026	0.993	11.5
28100.824	1935	+2356	−0.086	0.978	11.4
28164.718	1935	+2372	−0.290	0.928	11.5
28469.857	1936	+2448	+0.346	0.086	11.6
28525.683	1936	+2462	+0.123	0.030	11.4
30712.858	1942	+3008	−0.043	0.989	11.4

All photographic data gathered at Harvard were folded with the elements mentioned above. For the dual purposes of clarity and illustration the data were grouped according to diminishing eclipse amplitude into four separate light curves, shown in Figure 1. The earliest observed dimming occurred in 1901 at an amplitude of 1.50 mag, but by 1908 the depth of primary minimum was on the order of $1\overset{m}{.}0$–$1\overset{m}{.}2$. From that time forward the eclipse becomes more shallow as reported by Woodward, and by 1920 the eclipse cannot have been more than $0\overset{m}{.}2$–$0\overset{m}{.}4$ deep. This decline in amplitude continued throughout the 1940's and our data suggests by mid-century the eclipses had turned off completely and had not returned as of 1989.

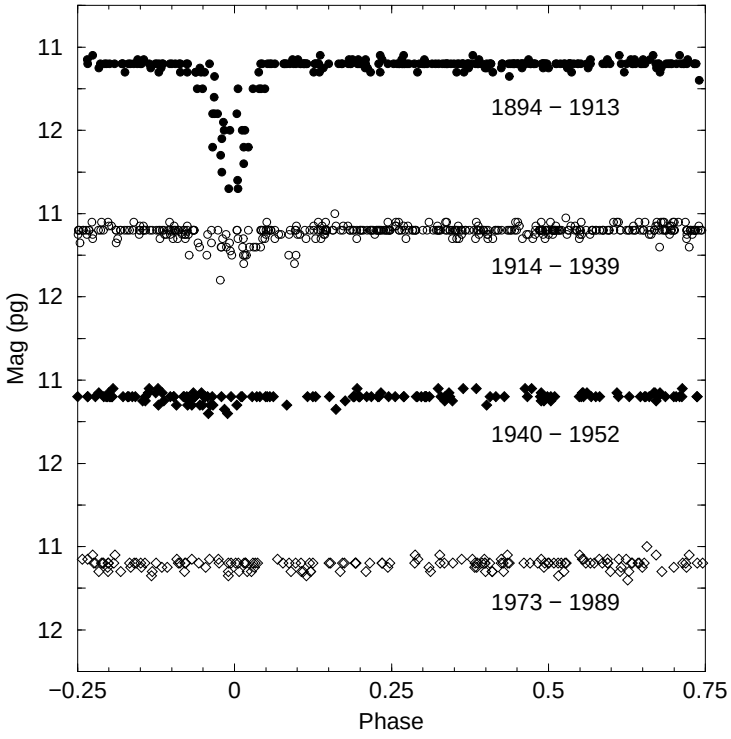

Figure 1. Phased light curve, SV Geminorum

Given that the period of SV Gem is very nearly equal to 4 sidereal days, observation of the system is difficult from any one geographical location, and it is therefore understandable that the star has been neglected. Visual monitoring by Guilbault during the calculated phases of eclipse on 2451512, 2451520 and 2451524, recent unfiltered CCD observation by Paschke at orbital phase 0.940 and at phases 0.12–0.02, and data gathered by the Hipparcos satellite at phase 0.96 through phase 0.12 have failed to show any convincing evidence of variability at the present time.

SV Geminorum therefore belongs to a select group of eclipsing binary stars in which dramatic light changes can be observed over a relatively short period of time. Our data, together with the observations of Woodward (1943) and Whitney (1959), show the cessation of eclipses to have occurred shortly after 1942. Other systems that have exhibited similar behavior are V907 Scorpii (Sandberg Lacy et al. 1999), whose eclipses have turned on and off twice within modern history, and SS Lacertae (Milone et al. 2000, Torres and Stefanik 2000) whose eclipses have ceased altogether.

Similarly in SV Gem, the most likely explanation for the disappearing eclipses is apsidal

motion or nodal regression of the eclipsing binary caused by a third body. However, both require that the orbit is eccentric and Lucy and Sweeney's orbital solution is circular. The data are from Struve's original paper so the orbit is in desperate need of a modern determination. Without an accurate orbit and reliable spectral types for the components it is impossible to estimate when SV Gem will start eclipsing again, but given the speed of the disappearance of the eclipses the apsidal or nodal period may be relatively short. However, as it has been about 50 years since any obvious eclipses the definition of short is relative.

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