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THE NATURE OF THE ECLIPSING BINARIES SS Hya AND VW Cet

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SS Hya and VW Cet are long-neglected eclipsing binaries that have had suspicions raised about their variability. All the available photometry has been reviewed and additional measurements have been made recently of both stars by West using a 0.2-m f/6.3 Schmidt Cassegrain telescope with ST8 and ST9E CCD cameras, and a V filter.

SS Hya ($13^{\rm h}30^{\rm m}29\overset{\rm s}{.}51$ $-23°38'58\overset{''}{.}2$) is bright, V = $7\overset{\rm m}{.}9$ with a spectral type of A0 V (Houk & Smith-Moore, 1988) and is listed in the GCVS (Kholopov et al., 1998) as an EA: system on the basis of over 900 photographic observations by Gaposchkin (1950), but no period is known. Gaposchkin found a range of 8.10 to 8.30: pg, which is probably barely larger than for constant stars, but made the comment, 'eclipsing?'. The star has a long history of suspected variability and was included in variable star catalogues long ago. The discoverer, Bemporad (1911) found variations between $7\overset{\rm m}{.}4$ and $8\overset{\rm m}{.}1$ from his visual observations of 1908–1911 and derived the elements $JD_{Max} = 2419207.4 + 8\overset{\rm d}{.}20 \times E$, with $M - m = 3$d. Despite the brightness of the star there is very little modern photometry. A small number of new measurements reported here give $V = 7\overset{\rm m}{.}89 \pm 0\overset{\rm m}{.}04$, which is generally consistent with the uncertainties. Cousins & Lagerwey (1970) made four measurements and derived mean values of, $V = 7\overset{\rm m}{.}88, (B - V) = 0\overset{\rm m}{.}00, (U - B) = -0\overset{\rm m}{.}06$, with the comment, 'Variable', and although there is no indication of range, this comment does need to be considered seriously.

Data are also available from Hipparcos and ASAS3. The Hipparcos data are effectively constant at $Hp = 7.907 \pm 0.018$, with two apparently discordant points 0.05 and 0.1 mag fainter than the rest. A Discrete Fourier Transform periodogram (DFT) of all the Hipparcos data shows no periodic variation greater than 0.015 mag for frequencies up to 10 cycle day^{-1}, and without these two points the limit becomes 0.010 mag.

SS Hya is very close to the saturation limit for the ASAS3 instrument and prior to a detector change at $JD = 2452200$ was in fact above it, which sometimes produced spurious variations of up to 0.9 mag. The measurements of SS Hya after this date, and with errors < 0.03 mag, are effectively constant at $V = 7\overset{\rm m}{.}896 \pm 0\overset{\rm m}{.}011$. There are a few discordant points, up to 0.05 mag adrift, but the DFT periodogram shows no periodic variation greater than 0.006 mag for frequencies up to 10 cycle day^{-1}.

In summary the photometry suggests that SS Hya is not an obvious variable; at most the full amplitude must be < 0.03, which is well below the range of photographic or

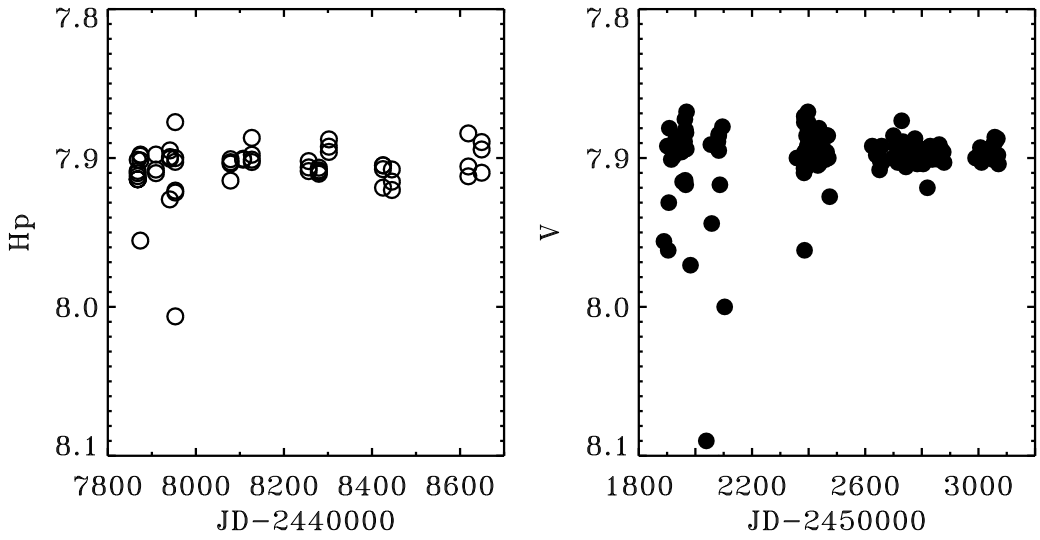

Figure 1. The light curve of SS Hya from the Hipparcos data (left) and the ASAS3 data (right). All the ASAS3 data prior to $JD = 2452200$ are suspect due to saturation problems and many of the fainter points lie off the plot.

visual detection. The only remaining doubt about its lack of variation is the comment by Cousins & Lagerwey, otherwise there would be no suggestion that it was variable at all.

Adams et al. (1924) give two radial velocities, apparently for two components, of −98 and +117 km s^{-1} with the comment, 'Double lines. Doubtless *Algol* type'. If it is an Algol system then the secondary is sufficiently bright to be seen spectroscopically. In contrast, the General Catalogue of Stellar Radial Velocities (Wilson, 1953) gives a mean velocity of +10 km s^{-1} with the poorest quality flag (E), based on just two measurements. If the large velocity variation and double lines are correct then the system must contain stars with similar luminosities and not too dissimilar masses. If the components are both approximately A0 V then a period, $0.5 < P < 2$ days is required to generate the velocity range, depending on the inclination. As there are no obvious eclipses the longer periods are physically impossible, and with $P \sim 1$ day an inclination, $i < 40$ is required to avoid eclipses, which is not unrealistic. If it is an Algol system then everything depends on the mass ratio, but both stars will still have broadly similar sizes and the inclination requirement will remain approximately the same. It therefore seems possible that SS Hya is a low-inclination binary, possibly showing very low-amplitude ellipsoidal or grazing eclipse variations.

The Hipparcos parallax of SS Hya is 5.80 ± 1.07 mas which leads to 1-σ absolute magnitude of, $1\overset{\mathrm{m}}{.}25 < M_V < 2\overset{\mathrm{m}}{.}06$. Interstellar extinction should be small as at < 200 pc the star is only just beyond the local bubble (Sfeir et al., 1999). A ZAMS A0 V star is expected to have $M_V = 1.5$, and more general values are up to a magnitude brighter, which leaves little leeway for an additional component. A significantly less luminous secondary might be accommodated, but unless the parallax is badly in error, two stars of similar luminosity are not possible.

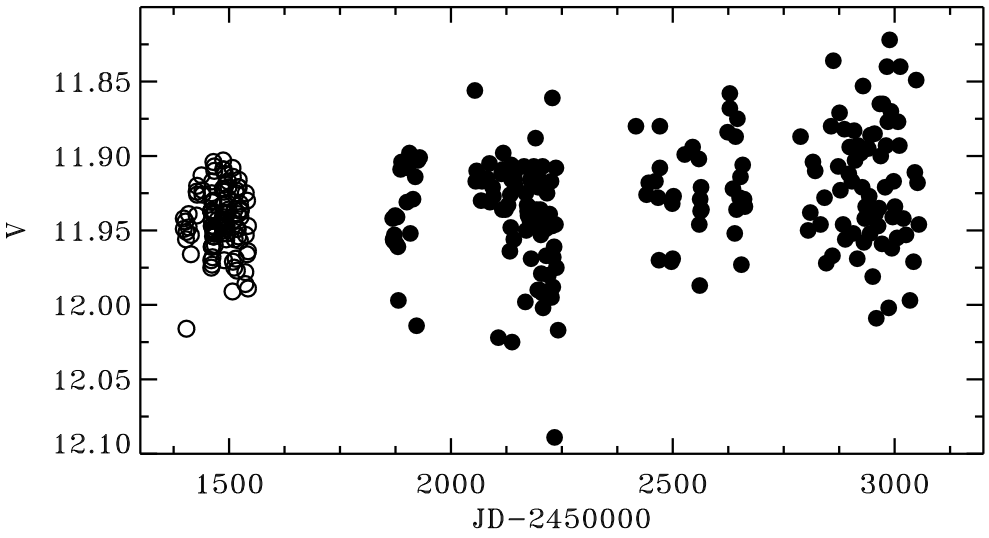

Figure 2. The light curve of VW Cet showing the unfiltered ROTSE data (open circles) and the ASAS3 V data (filled circles).

VW Cet ($01^{\rm h}39^{\rm m}04\overset{\rm s}{.}31$ $-17^\circ 50' 48\overset{''}{.}4$) is listed in the GCVS (Kholopov et al., 1998) as a short-period eclipsing binary of uncertain type, EB/KW:. It was discovered by Petit (1953) who reported a short-period eclipsing variable of β Lyrae or W UMa type with a visual range of $11\overset{\rm m}{.}6$ to $12\overset{\rm m}{.}1$. These variations were apparently confirmed by 35 observations by Oskanjan (1953), with a visual range of 11.6 to 12.2, and a period about 0.24 days. Finally, Petit (1956) derived the published ephemeris $JD_{Min} = 2435111.396 + 0.486 \times E$ based upon 110 visual estimates. There have been no further measurements until very recently.

Our new observations of VW Cet have been obtained serendipitously since 2001 during a programme to monitor UV Cet, which lies close by. These 96 observations have $V = 11\overset{\rm m}{.}979 \pm 0\overset{\rm m}{.}064$, which is broadly consistent with the uncertainties, but they show no suggestion of a 0.486 day variation. A DFT periodogram of these data is essentially noise with no periodic variation greater than 0.025 mag for frequencies up to 10 cycle day^{-1}.

VW Cet has also been observed by ASAS3 and ROTSE. Limiting the ASAS3 data to those with errors < 0.03 mag and ignoring one discordant point (leaving 197 points), gives $V = 11\overset{\rm m}{.}930 \pm 0\overset{\rm m}{.}039$. A DFT periodogram of these data shows no periodic variation greater than 0.021 mag for frequencies up to 10 cycle day^{-1}. Similarly, restricting the ROTSE-1 data to those with errors < 0.03 mag (115 points) gives $M_{ROTSE} = 11\overset{\rm m}{.}943 \pm 0\overset{\rm m}{.}020$, and the maximum periodic variation from the DFT periodogram is 0.011 mag. A very similar limit is also found for the combined ASAS3 and ROTSE data sets.

In summary there is no evidence for the 0.486 day period for VW Cet and there is no reason to believe there is any periodic variation at all. The total extinction in this direction from the NASA/IPAC Extragalactic Database is very low, $A_V = 0\overset{\rm m}{.}06$ so the 2MASS colours $J - H = 0\overset{\rm m}{.}46(3)$ and $H - K = 0\overset{\rm m}{.}08(3)$ should be very close to intrinsic, and suggest that VW Cet has a spectral type close to K0. It has a small but significant proper motion so it is most likely a field dwarf.

West's photometry of SS Hya and VW Cet is available through the IBVS website as `5529-t1.txt` and `5529-t2.txt` respectively.

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