THREE NEW W UMa BINARIES: GSC 0766-1248 (Brh V40), GSC 0471-2133 (Brh V60) AND GSC 0763-0572 (Brh V103)

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Further observations are presented of three new W UMa systems recently discovered by Bernhard (2000a, 2000b, 2002). Details of the observing programme are given by Bernhard & Lloyd (2000) and an up-to-date list of the variables can be found at `http://mitglied.lycos.de/klausbernhard/`. Details of the equipment used are given by Lloyd et al. (2002) and Bernhard et al. (2001).

Table 1: Brh V40 - Times of minima

HJD	Cycle	$O - C$	Min
2451924.4334(11)	−24	+0.0001	I
2451951.3609(8)	0	+0.0004	I
2451955.2867(13)	3	−0.0007	II
2451965.3864(6)	12	+0.0013	II

Brh V40 = GSC 0766-1248 ($07^{\mathrm{h}}13^{\mathrm{m}}34\overset{\mathrm{s}}{.}142$ $+10°15'12\overset{''}{.}91$ Tycho-2) was initially reported as a short-period variable by Bernhard (2000a) on the basis of six nights of survey data. Brh V40 has $V = 11\overset{\mathrm{m}}{.}42 \pm 0\overset{\mathrm{m}}{.}10$ and $B - V = +0\overset{\mathrm{m}}{.}40 \pm 0\overset{\mathrm{m}}{.}14$ from the Tycho-2 catalogue (Høg et al. 2000), while the USNO A2.0 catalogue gives a consistent $r = 12\overset{\mathrm{m}}{.}0$ and $b - r = 1\overset{\mathrm{m}}{.}0$ (Monet et al. 1998). Further extensive photometry during 2001 and 2002 has confirmed that it is a W UMa binary with a period of just over one day. The reference star used was GSC 0766-0142 with $V = 12\overset{\mathrm{m}}{.}11$ (Tycho-2). A total of four minima have been observed which are given in Table 1. The ephemeris of primary minimum is given by

$$\mathrm{HJD}_{\mathrm{MinI}} = 2451951.3605 + 1\overset{\mathrm{d}}{.}121968 \times E \ .$$
$$\pm 5 \qquad\quad \pm 6$$

The light curve is given in Figure 1 and shows an amplitude of nearly $0\overset{\mathrm{m}}{.}6$. The secondary eclipse is slightly less deep and is probably total, indicating that the inclination
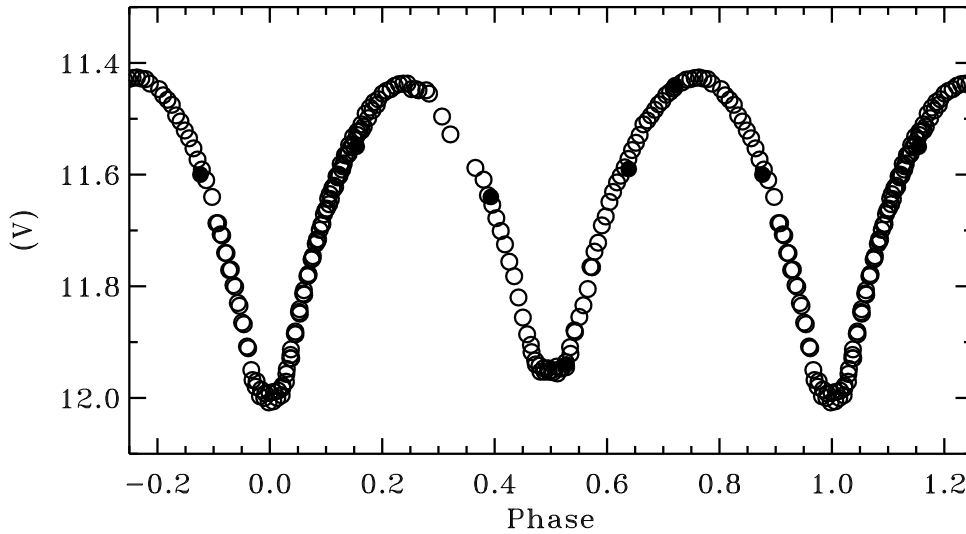
Figure 1. The phase diagram of Brh V40 = GSC 0766-1248. The observations of Moschner (open circles) and Bernhard (filled circles) are folded with the ephemeris given in the text.

is close to 90°. The period is long for a W UMa system: it lies in the top $\sim 1\%$ of the EW variables in the GCVS (Kholopov et al. 1998) and these systems are often not in contact (classified EW/D or /DM) or are referred to as Beta Lyrae variables (EB/...). Typical systems in this group are AT Cam (EW/DM:) and AZ Cam (EB/DM), which are probably just detached (Zhai et al. 1984). However, while their amplitudes are similar to that of Brh V40 their light curve are less sinusoidal, suggesting that Brh V40 is more nearly a contact system.

<div align="center">

Table 2: Brh V60 - Times of minima

HJD	Cycle	$O - C$	Min
2451838.2531(14)	−1066	+0.0003	II
2452464.5607(13)	0	+0.0028	I
2452475.4301(8)	18	−0.0022	II
2452484.5417(9)	34	−0.0015	I
2452489.5412(19)	42	+0.0016	II
2452556.2575(18)	156	+0.0022	I

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Brh V60 = GSC 0471-2133 ($19^{\mathrm{h}}14^{\mathrm{m}}39\fs648$ +03°50′39″.85 Tycho-2) was initially reported as a probable short-period variable of unknown type by Bernhard (2000b). Photometry from Tycho-2 gives $V = 12\fm0 \pm 0\fm2$ and $B - V = -0\fm2 \pm 0\fm3$ while USNO A2.0 gives $r = 11\fm6$ and $b - r = 0\fm8$. Extensive photometry during 2000 and 2002 has shown that it is a W UMa system, although the colour suggests that it is probably an early spectral type. The reference star used was GSC 0471-2309 with $V = 11\fm67$ (Tycho-2). Six times of minima have been observed and these are given in Table 2. The ephemeris of primary minimum is given by

$$\mathrm{HJD_{MinI}} = 2452464.5579 + 0\fd5878039 \times E \ .$$
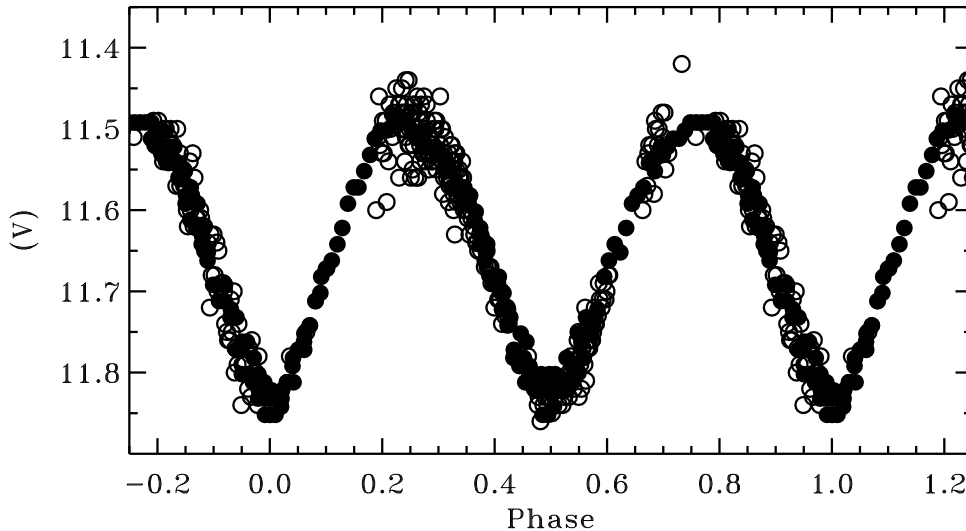$$\qquad\quad \pm 5 \qquad\qquad \pm 7$$

Figure 2. The phase diagram of Brh V60 = GSC 0471-2133. The observations of Bernhard (open circles) and Frank (filled circles) are folded with the ephemeris given in the text.

The light curve is given in Figure 2 and shows an amplitude of $0^{m}35$, with both minima reaching almost the same depth. The secondary minimum may be marginally less deep than the primary, and is apparently broader, but the eclipse is probably not total.

Table 3: Brh V103 - Times of minima

HJD	Cycle	$O - C$	Min
2452318.0524(3)	−43	−0.0006	I
2452325.0886(2)	−27	+0.0002	II
2452336.3876(4)	0	−0.0001	I
2452361.3321(5)	58	+0.0007	II
2452362.3974(6)	61	+0.0000	I

Brh V103 = GSC 0763-0572 ($07^{h}16^{m}57^{s}323$ $+09°12'35''46$ Tycho-2) was initially reported as a short-period variable by Bernhard (2002) following several long runs of observations. It has $V = 10^{m}61 \pm 0^{m}06$ and $B - V = +0^{m}64 \pm 0^{m}09$ from the Tycho-2 catalogue, and $r = 10^{m}4$ and $b - r = 1^{m}0$ from the USNO A2.0 catalogue. Further extensive photometry during 2002 has shown that it is W UMa binary. The reference star used was GSC 0763-0631 with $V = 9^{m}82$ (Tycho-2). Five times of minima have been observed and these are given in Table 3. The ephemeris of primary minimum is given by

$$\mathrm{HJD}_{\mathrm{MinI}} = 2452336.3877 + 0^{d}426388 \times E \ .$$
$$\pm 4 \qquad\qquad \pm 3$$

The light curve is given in Figure 3 and shows an amplitude of $0^{m}5$. The secondary eclipse is slightly less deep and is probably total, indicating that the inclination is close to 90°. The instrumental $V - I_c$ from the TASS archive (http://www.tass-survey.org) shows a small variation in colour with the system being coolest during primary minimum.
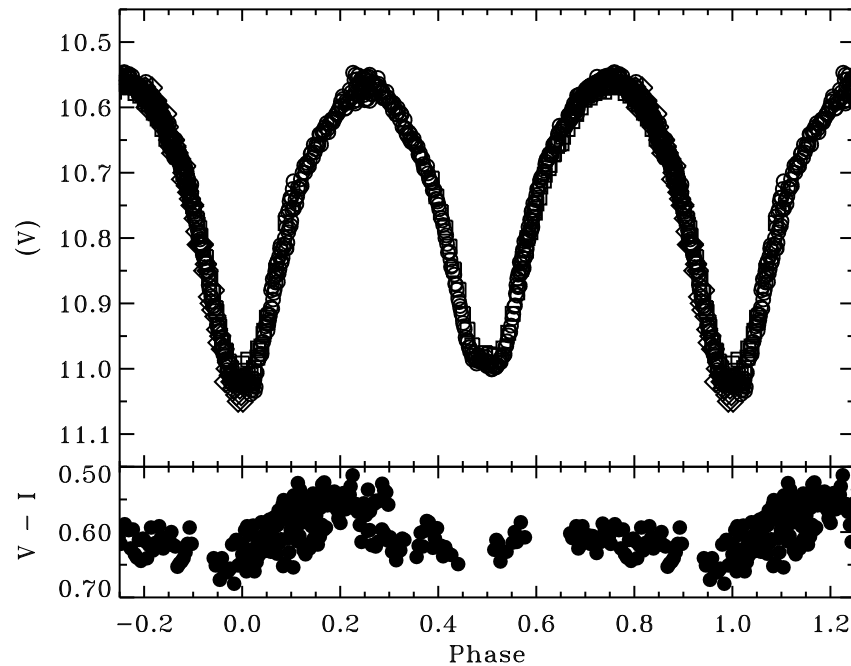
Figure 3. (Above) The phase diagram of Brh V103 = GSC 0763-0572. The observations of Moschner (open squares), Kiyota (open circles) and Bernhard (open diamonds) are folded with the ephemeris given in the text. (Below) The TASS instrumental $V - I_c$ magnitudes.

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