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TWO NEW ECLIPSING BINARIES: V1626 Ori (Brh V38) AND GSC 0486-4828 (Brh V64)

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Further observations and analysis are presented of two suspected eclipsing binaries recently discovered by Bernhard (2000a, 2000b). Further details of the program 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 Quester & Bernhard (2001).

V1626 Ori = BrhV38 = GSC 0721-2377 ($06^h05^m20\overset{s}{.}118$ $+10°04'25\overset{''}{.}54$ Tycho-2) was initially reported as a possible eclipsing system by Bernhard (2000a) on the basis of eight nights of survey data. Further photometry on 16 nights have confirmed that it is an eclipsing binary with a period of just over one day. The reference star used was GSC 0721-0968 with $V \approx 12\overset{m}{.}2$. Two primary minimum have been observed and the times are given in Table 1. The ephemeris of primary minimum is given by

$$HJD_{\mathrm{MinI}} = \underset{\pm 29}{2452223.5824} + \underset{\pm 3}{1\overset{d}{.}137793} \times E$$

V1626 Ori appears at the limit of the Tycho-2 catalogue (Høg et al. 2000) with a rather unreliable $V = 12\overset{m}{.}5 \pm 0\overset{m}{.}3$ and $B - V = -0\overset{m}{.}1 \pm 0\overset{m}{.}4$ while the USNO A2.0 catalogue gives $b = 11\overset{m}{.}6$ and $b - r = 0\overset{m}{.}7$ (Monet et al. 1998).

A photometric model of the system has been derived using the LIGHT2 code (see Hill et al., 1989). In this system there is nothing to guide to choice of mass ratio but given the difference in the eclipse depths it is likely that $q < 0.5$. A range of mass ratios, $1.0 > q > 0.1$, and temperatures have been explored and it must be conceded that a wide variety of photometric parameters provide almost identical fits to the light curve. However, only a small range of models are physically consistent with the primary being

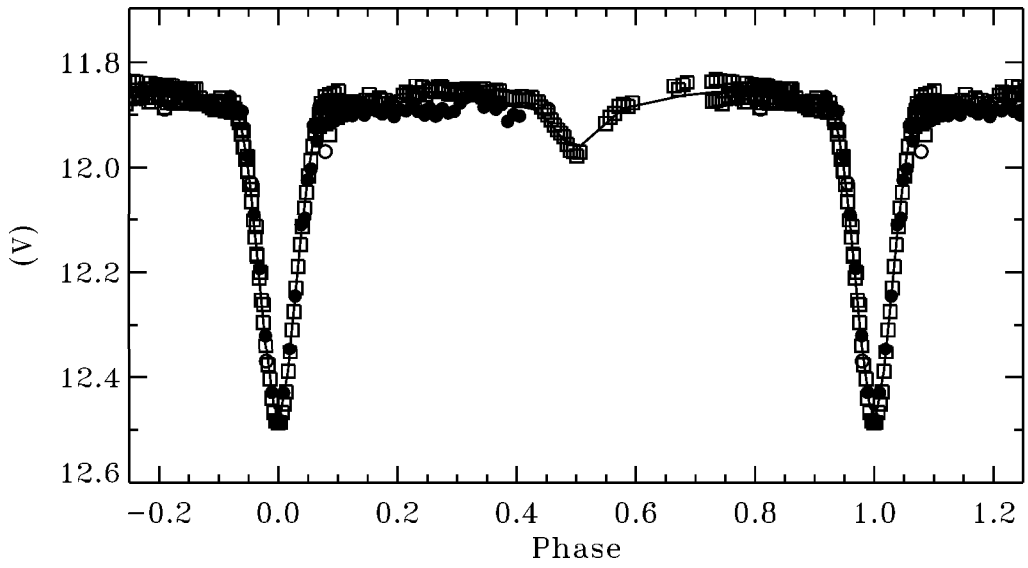

Figure 1. The phase diagram of V1626 Ori = Brh V38 assuming that the reference star GSC 0721-0968 has $V = 12\overset{m}{.}2$. The CCD observations of Moschner (open squares), Frank (filled circles) and Bernhard (open circles) are folded with the ephemeris given in the text. The fit is described in the text.

a main-sequence star, and these have $T_1 \sim 6600$ and $q < 0.5$, corresponding to an F5 V star. The parameters are only weakly dependent on q, but with $q < 0.2$ the secondary fills its Roche lobe.

The fit to the light curve shown in Figure 1 was obtained with $q = 0.3$ and $T_1 = 6600$ K (fixed), yielding $T_2 = 4600 \pm 100$ K, $i = 77° \pm 1°$, $R_1/a_0 = 0.23 \pm 0.01$ and $R_2/a_0 = 0.24 \pm 0.02$. A star of spectral type F5 V, has $M = 1.4\mathrm{M}_\odot$ and $R = 1.3\mathrm{R}_\odot$ (Cox 2000), giving $a_0 = 5.8$ R$_\odot$, and $R_1 = 1.3\mathrm{R}_\odot$ from the model. The temperature of the secondary corresponds to an early K-type star with a radius, $R_2 = 1.4\mathrm{R}_\odot$, which is substantially larger than expected for an early K-type star. For $q < 0.5$ there is little to separate the solutions so the secondary may fill its Roche lobe or is close to it. If it does fill its Roche lobe then $q < 0.2$, implying $M_2 < 0.3\mathrm{M}_\odot$.

Table 1: Brh V38 - Times of minima

HJD	$O-C$	Min	HJD	$O-C$	Min
2451957.3379(12)	−0.0009	I	2452223.5824(3)	+0.0000	I

BrhV64 = GSC 0486-4828 ($19^\mathrm{h}34^\mathrm{m}21\overset{s}{.}486$ $+03°54'43\overset{''}{.}33$) was initially reported as a probable eclipsing system by Bernhard (2000b) following several long runs of observations. Further extensive photometry during the 2000 and 2001 observing seasons has confirmed that it is an eclipsing binary, with a period of just under ten days. In total four minima have been observed and they are given in Table 2. The reference star used was GSC 0486-3453 with $V \approx 12\overset{m}{.}3$. The ephemeris of primary minimum is given by

$$HJD_{\mathrm{MinI}} = \underset{\pm 103}{2452137.5441} + \underset{\pm 5}{9\overset{d}{.}27850} \times E$$

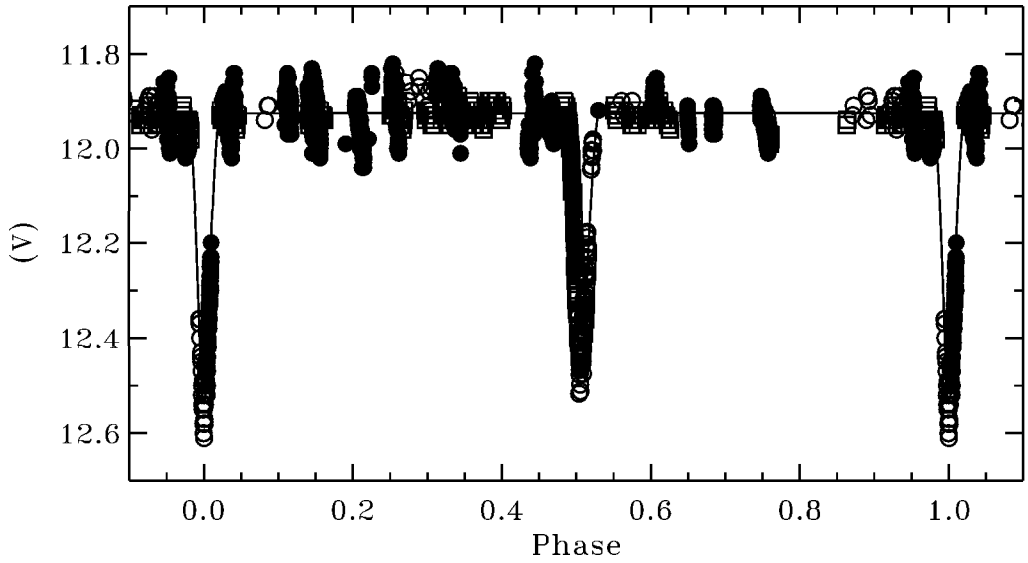

Figure 2. The phase diagram of BrhV64 = GSC 0486-4828 assuming that the reference star GSC 0486-3453 has $V = 12\overset{\text{m}}{.}3$. The CCD observations of Frank (open squares), Quester (open circles) and Bernhard (filled circles) are folded with the ephemeris given in the text. The fit is described in the text.

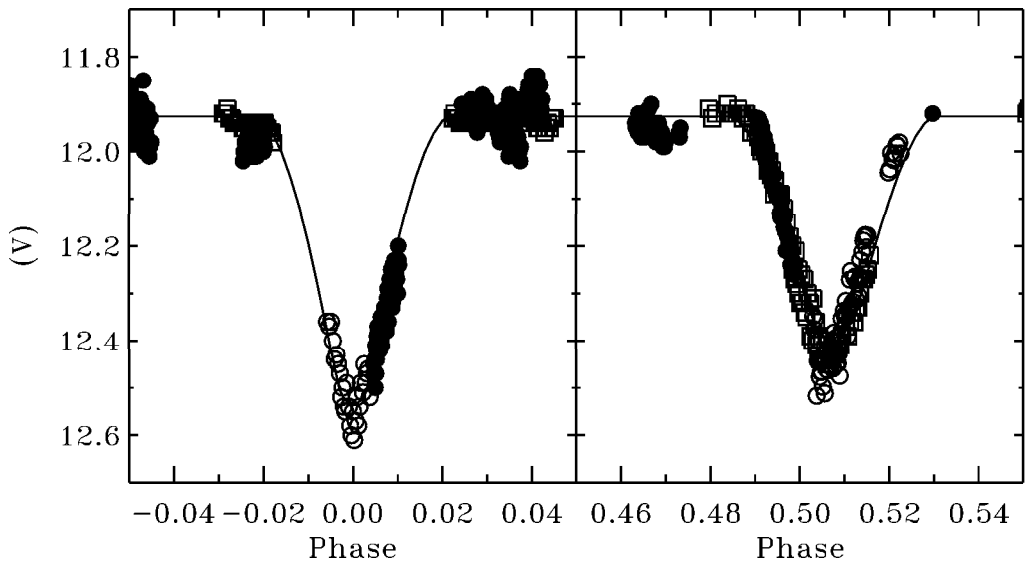

Figure 3. Detail of the primary and secondary minima. The symbols are as in Figure 2.

Table 2: Brh V64 - Times of minima

HJD	$O-C$	Min	HJD	$O-C$	Min
2452137.5441(17)	+0.0000	I	2452179.3590(7)	+0.0013	II
2452151.5251(11)	+0.0029	II	2452448.4309(29)	−0.0033	II

The light curve, given in Figure 2, shows that both eclipses are nearly equal in depth, at close to $0\overset{\mathrm{m}}{.}7$, indicating that the system contains two similar stars. Figure 3 shows that there is a small but clear difference in the eclipses, which eliminates the half period, but also that the secondary eclipse is slightly displaced, to $\phi = 0.5065$, indicating a small eccentricity.

A photometric model of the system has again been derived using the LIGHT2 code (see Hill et al., 1989). The mass ratio is unknown but given the similarity of the eclipses it is reasonable to assume initially that $q \sim 1.0$. Similar fits to the light curve are found for a range of temperatures, so T_1 and T_2 are unconstrained, but the relative radii are found to be almost independent of temperature. A temperature for the primary, $T_1 = 10\,500$ K has been adopted as this provides a physically consistent set of values for both stars, assuming that they lie on the main sequence.

Adopting $q = 1$ and $T_1 = 10\,500$ K (fixed), gives $T_2 = 10\,000 \pm 100$ K, $R_1/a_0 = 0.080 \pm 0.002$, $R_2/a_0 = 0.063 \pm 0.002$, $i = 89\overset{\circ}{.}8 \pm 0\overset{\circ}{.}2$, $e = 0.04 \pm 0.01$ and $\omega = 74^\circ \pm 6^\circ$. This fit is plotted in Figures 2 and 3. The primary corresponds to a main-sequence star near spectral type B9, which has $M = 3.3$ $M_\odot$ and $R = 2.7$ $R_\odot$ (Cox 2000), giving $a_0 = 34.0$ $R_\odot$, and $R_1 = 2.7$ from the model. The secondary is marginally cooler and smaller, with $R_2 = 2.2$ $R_\odot$, making it an early A-type star. This result is also consistent with the Tycho-2 photometry which gives $V = 11\overset{\mathrm{m}}{.}96 \pm 0\overset{\mathrm{m}}{.}13$ and $B - V = 0\overset{\mathrm{m}}{.}08 \pm 0\overset{\mathrm{m}}{.}23$. As the system is detached, apparently unevolved, and has $i = 90^\circ$ it would appear to be an ideal candidate for testing the fundamental parameters of main-sequence stars.

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