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DISCOVERY OF THE VARIABILITY OF GSC 1009.766 AND GSC 1057.1309

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CCD observations of selected fields on the edge of the northern Milky Way have been made as part of a programme to discover and classify new variables (eg. Bernhard et al. 1997, Bernhard 1999). In this paper the observations of two new variables resulting from this programme are reported. GSC 1009.766 is an EA binary with a period of 2.16252 days and GSC 1057.1309 is a short-period variable, possibly a β Cephei, δ Scuti or W UMa variable. Following the practice in previous reports of discoveries from this programme these stars are also referred to as BeV7 and BeV8 respectively. The observations were made using a 20-cm Schmidt-Cassegrain telescope and a Starlight Xpress SX CCD camera without filter. In each observing run typically 300 images are taken of several survey fields. The CCD camera uses a Sony ICX027B chip which has a very broad response, peaking near 5500 Å, giving approximate V-band magnitudes. The frames are processed automatically; de-biased using a mean dark frame and flat fielded. The magnitudes are derived using a simple aperture photometry procedure with a 5×5 pixel square for the star+sky and 7×7 pixel square window frame for the sky.

GSC 1009.766

GSC 1009.766 is classified as non stellar in the Guide Star Catalog and this is attributable to a faint companion, which is clearly seen on the CCD images, but is not completely resolved from the brighter, variable component. The separation between the two components is estimated to be about 2 pixels, or ∼5 arcsec on the sky. All the magnitude estimates of GSC 1009.766 completely include the faint companion. Examination of the images suggests that the faint companion is *slightly* fainter than the variable at minimum light, although this estimate is rather subjective. The comparison stars used were GSC 1009.1116 (GSC 11.0) and GSC 1009.842 (12.2), and showed a constant magnitude difference consistent with the GSC magnitudes. The magnitude scale used assumes that GSC 1009.1116 has V = 11.0.

GSC 1009.766 was observed 113 times during the second half 1998. Initially, during the survey phase the observations are relatively sparse but following the discovery of variations the star was observed more intensively. The observations show GSC 1009.766 to be an Algol-type eclipsing binary with primary and secondary eclipses of ∼ 0.5 and 0.1 mag respectively. The ephemeris of primary minimum is

$$\text{Min. I} = \text{JD}2\,451\,072.55(\pm 0.02) + 2\overset{\text{d}}{.}16252(\pm 0.00023) \times E.$$

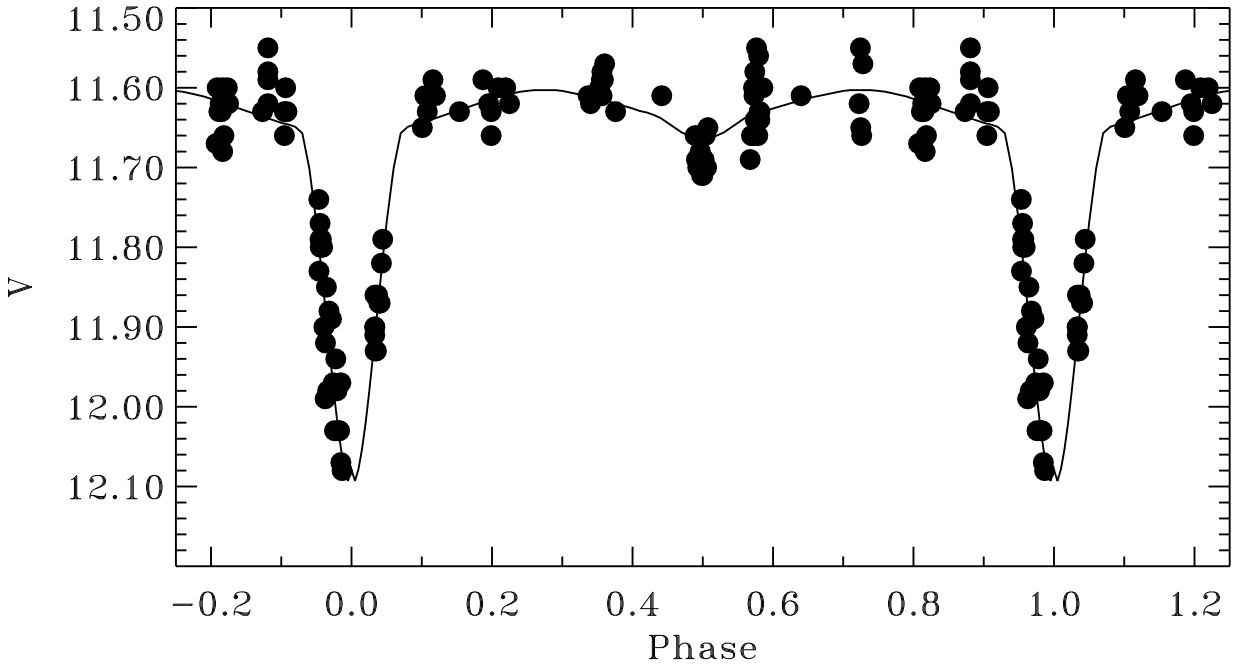

Figure 1. The observed light curve of GSC 1009.766 with a photometric solution, assuming no contribution from the faint companion

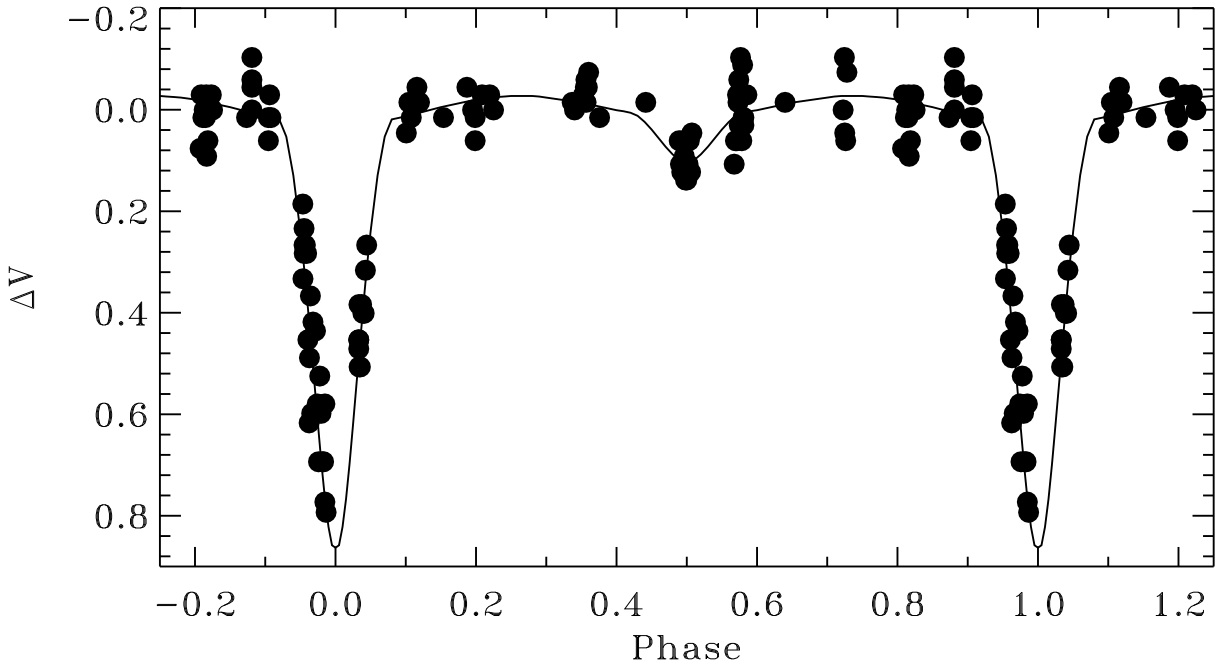

Figure 2. The relative light curve of GSC 1009.766 corrected for the contribution from the faint companion, with a solution over plotted.

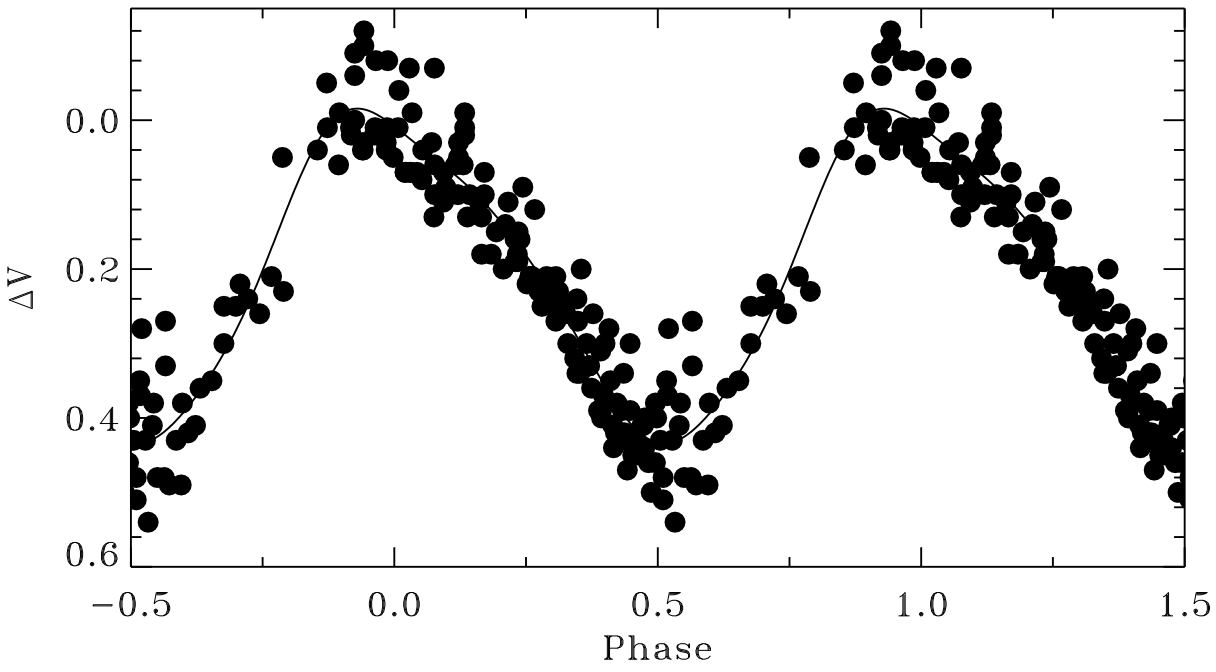

Figure 3. The light curve of GSC 1057.1309 folded with a period of 0.172675 days.

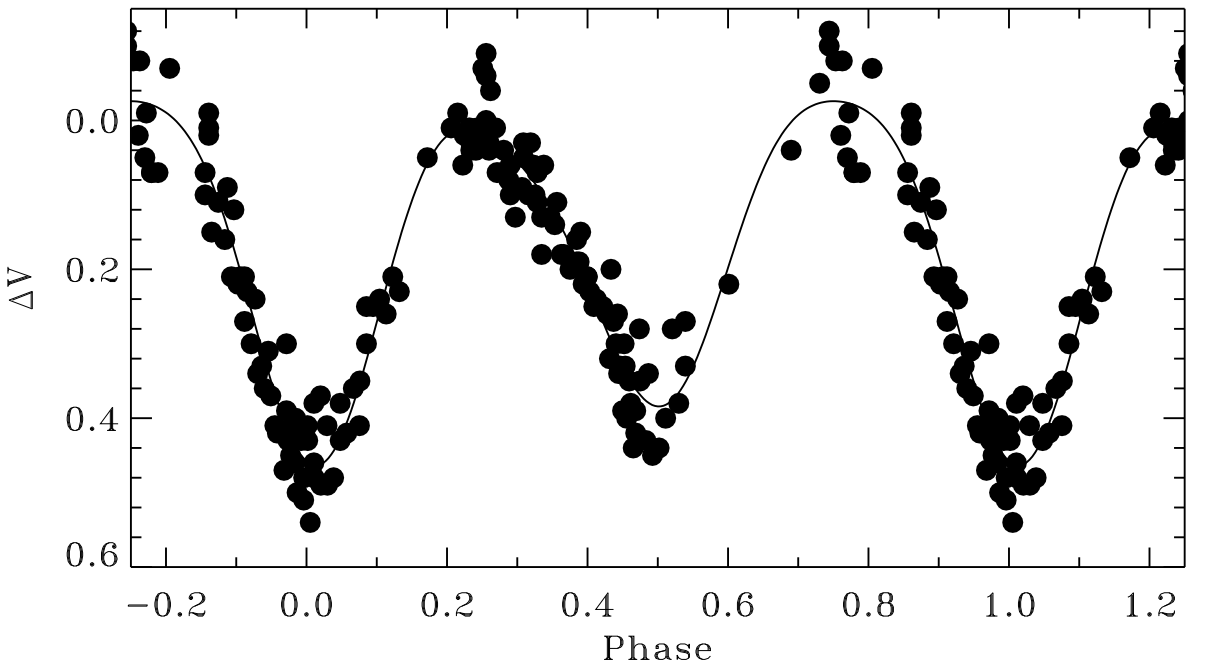

Figure 4. The light curve GSC 1057.1309 folded with a period of 0.417570 days.

Attempts to produce viable light curves with alias periods have failed, so insofar as it is possible to determine, this period is unambiguous.

An attempt has been made to model the system using the LIGHT2 code of Hill et al. (1989). In the first instance it has been assumed that the faint companion makes no contribution to the light curve. The solution plotted over the observed light curve is shown in Figure 1. For the second solution the faint companion was assumed to contribute a constant luminosity equivalent to the variable at minimum light (which is probably too large) and the light curve had this constant component removed. The corrected relative light curve and solution are shown in Figure 2.

Without any other photometric or spectroscopic information about this system the photometric solutions are poorly constrained. A wide range of system parameters give very similar light curves. The ratio of stellar temperatures is ~ 1.5–2, although the temperatures themselves are largely unconstrained. The radii of the two stars are broadly similar but secondaries both larger and smaller than the primary are possible depending on the mass ratio. The solutions in which the secondary is constrained to fill its Roche lobe are equally consistent with the light curve. For the solution plotted in Figure 1 the secondary fills its Roche lobe and the other parameters are; $T_1 = 10000$ K (fixed), $T_2 = 5200 \pm 400$ K, $R_1/a = 0.22 \pm 0.02$, $R_2/a = 0.30$ (fixed), $i = 71 \pm 1$, $q = 0.5$ (fixed). A similar solution is shown in Figure 2 for the corrected light curve. The true variation of GSC 1009.766 will lie between these two extremes (with ΔV between 0.5 and 0.8 mag) and the evidence suggests it is a classical Algol binary.

GSC 1057.1309

GSC 1057.1309 was observed 163 times between July and November 1998 with several runs of approximately 20 observations. The magnitudes are given relative to GSC 1057.1973 (11.8) and the second comparison star used was GSC 1057.1527 (12.7). From a period analysis of the observations GSC 1057.1309 appears to be a short period variable although it is not possible to derive the period unambiguously. Four possible periods emerge, two with single maxima and minima, characteristic of a β Cephei or δ Scuti variable, and double these periods, giving two maxima and minima, characteristic of a W UMa variable. Arguably the most likely period is 0.172675$\pm$0.000006 days, which is shown in Figure 3, although there is some suggestion of secondary variations superimposed. For a β Cephei or δ Scuti variable other periods may be present which would easily account for this additional variation. The other single maximum period is 0.208791$\pm$0.000007 days which shows a very similar variation and evidence of possible secondary periods.

The two other periods, 0.345346$\pm$0.000010 and 0.417570$\pm$0.000015 days, show W UMa-like light curves, but there are asymmetries in slope and differences in both the maxima and minima which are not typical of classical W UMa stars. These light curves also show scatter that would have to be interpreted as cycle to cycle variation. The light curve of the 0.417570 days period is shown in Figure 4.

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