COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5387

Konkoly Observatory
Budapest
3 March 2003

HU ISSN 0374 – 0676

PHOTOMETRIC OBSERVATIONS OF VW LMi AND THE NEW BINARY SYSTEM V345 Gem

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In this paper we present new observations of the HIPPARCOS variables VW LMi and V345 Gem from Mollet and Monegrillo Observatories. At both places telescopes were fitted with a SX Starlight CCD camera with a Sony ICX027BL chip cooled by a Peltier system to about $-25°$C. Dark frames and flat fields were obtained and used to perform image cleaning. Photometric observations were taken in the B and V bands, and reductions were carried out using a synthetic aperture differential magnitude extraction method and the software package `LAIA` (Laboratory for Astronomical Image Analysis). Table 1 summarizes the observational log for both stars. Table 2 gives some additional basic data for these objects.

Table 1. Observational log

Star	HIP number	Observation period	Comparison star	Remarks*
VW LMi	HIP 54003	27 Dec 1997-24 Apr 1998	HIP 53969	1
V345 Gem	HIP 37197	25 Dec 1998-21 Mar 1999	HD 60913	2

*1: Mollet Observatory, 41 cm Newtonian telescope.

2: Mollet and Monegrillo Observatories, 41 cm Newtonian telescope.

Table 2. Basic data

Star	Spectral type	Equatorial coordinates (epoch 2000.0)	$B-V$**
VW LMi	F3V	$\alpha = 11^{\rm h}02^{\rm m}51\overset{\rm s}{.}909$ $\delta = +30°24'54\overset{''}{.}71$	0.410 ± 0.015
V345 Gem	F0	$\alpha = 07^{\rm h}38^{\rm m}30\overset{\rm s}{.}224$ $\delta = +33°42'41\overset{''}{.}51$	0.476 ± 0.015

**Spectral type and $B-V$ colour index retrieved from the HIPPARCOS Catalogue (ESA 1997).

VW LMi is a variable star discovered by the HIPPARCOS mission (ESA, 1997) and catalogued as an EW in the 74th Special Name-List (Kazarovets *et al.*, 1999). Dumitrescu (2000) reported ground-based photometric observations on this star and four minimum timings. In the HIPPARCOS catalogue the following ephemeris is given:

$$\text{Min. I} = \text{BJD } 2448500.1960(10) + 0^{\text{d}}.477547(3) \times \text{E}$$

We performed a new period analysis based on our new photometric data and the already existing observations. The new B and V light-curves also allowed computing a first estimate of some physical parameters for this binary system.

To recompute the period of VW LMi, an analysis of $O - C$ residuals based on times of minimum was performed. Table 3 lists the timings based on our observations. When the HIPPARCOS period (0.477547 days) was used, it was found to be a short estimate of the real one as indicated by an increasing trend of positive $O - C$ residuals. Assuming no period changes from 1991 to 2000, the trend was removed after a least squares linear fit, resulting in a new revolving time of 0.4775942(3) days for the binary system. Figure 1 shows the folded light-curves in the B and V bands using the new period. Although longer surveillance is still needed in the long term to monitor the behaviour of VW LMi, the satellite data and our photometry could be merged and satisfactorily folded on the new refined period, suggesting that it has remained stable during the 1991-2000 interval.

Table 3. Minimum timings for VW LMi

Minimum	Photometric band	Epoch
2450809.6214 ± 0.0002	V	4836.0
2450835.6495 ± 0.0002	V	4890.5
2450872.4224 ± 0.0001	V	4967.5
2450877.4658 ± 0.0001	V	4978.0
2450921.3707 ± 0.0002	B	5070.0

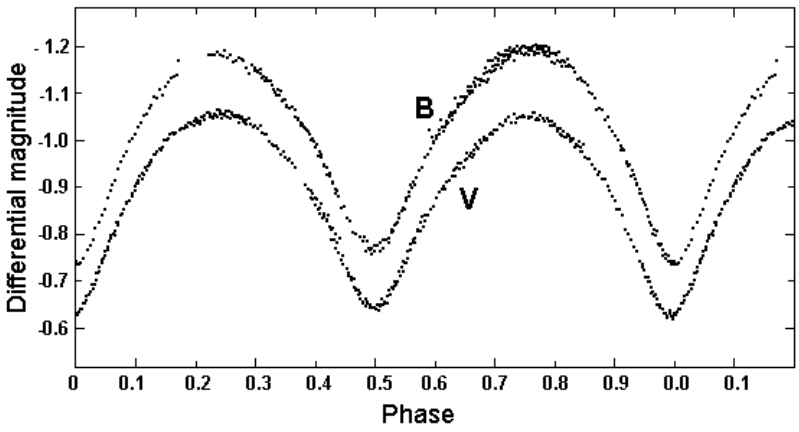

Figure 1. Differential B and V light-curves of VW LMi, folded with the period of 0.47754916 days obtained in this work

The differential B and V data were analysed using the Wilson-Devinney method (Wilson, 1998), assuming convective envelopes and a temperature of the primary ($T_1 = 6700$ K) according to the spectral type of VW LMi. Because the lack of information about the mass ratio, we varied it from 0.3 to 0.8 in steps of 0.1, performing for each value a complete set of cycles of refinement. The solution corresponding to the minimum residual (obtained for $q = 0.4$) suggests a system with an inclination of about 70°and relative luminosities (in both B and V bands) of 0.7 and 0.3 for the primary and secondary, respectively.

V345 Gem was also discovered by the HIPPARCOS mission, and catalogued as a periodic variable (ESA 1997) with a period of 0.1373890(5) days. An origin for maximum light was given at the BJD = 2448500.0260 (10), but no variable type was specified. In a preliminary search for EW candidates among the HIPPARCOS variables, Duerbeck (1997) classified V345 Gem as a suspected pulsating variable. This star was afterwards included in the 74th Special Name-List (Kazarovets et al., 1999) as DSCT. In subsequent literature, this object is still referred to as a δ Sct star (Rodriguez *et al.*, 2000), but later on Rodriguez and Breger (2001) indicated that it might be an EW with a 0.275-day period. V345 Gem is also the visual binary CCDM 07385+3343AB (Dommanget and Nys, 1994), consisting of a pair of 8.2 and 9.5 V magnitude stars separated by 3.0 arcseconds. Kazarovets *et al.* (1999) commented that "variability [of V345 Gem] might be due to the fainter (B) component".

This star was included in our observing program after concluding that its light-curve morphology, based on the HIPPARCOS photometric data folded on a 0.274778-days period (doubling that given in the HIPPARCOS Catalogue), suggested an EW or ELL type instead of a pulsating variable. Observations confirm that this star is an EW variable (Figure 2) with V and B amplitudes of 0.07 magnitudes, and primary minima about 0.005 magnitudes deeper than secondary minima in both B and V bands. Times of minimum from ground-based observations are listed in Table 4, which allowed, along with the HIPPARCOS data, to compute the following ephemeris:

$$\text{Min. I} = \text{BJD } 2448362.7224(10) + 0^{\text{d}}.2747736(2) \times \text{E}$$

Since our photometry actually consists of joint light measurements of the visual double system, if star A is the variable then the V amplitude is 0.10 mag, or 0.34 mag if component B is the eclipsing binary system.

Table 4. Minimum timings for V345 Gem

Minimum	Photometric band	Epoch
2451185.3344 ± 0.0004	B	10272.5
2451185.4730 ± 0.0003	B	10273.0
2451186.4350 ± 0.0003	B	10276.5
2451192.3396 ± 0.0004	B	10298.0
2451192.4772 ± 0.0008	B	10298.5
2451215.4217 ± 0.0002	V	10382.0
2451221.3292 ± 0.0002	V	10403.5
2451222.4275 ± 0.0002	V	10407.5
2451223.3904 ± 0.0005	V	10411.0
2451226.4131 ± 0.0005	B	10422.0
2451227.3723 ± 0.0006	B	10425.5
2451258.4240 ± 0.0004	B	10538.5

Acknowledgements: We would like to thank Joan A. Cano and Rafael Barberá for writing the software for obtaining and reducing the CCD frames. Use has been made of the SIMBAD database operated at the Centre de Données Astronomiques (CDS, Strasbourg, France) and the Astrophysics Data System (ADS).

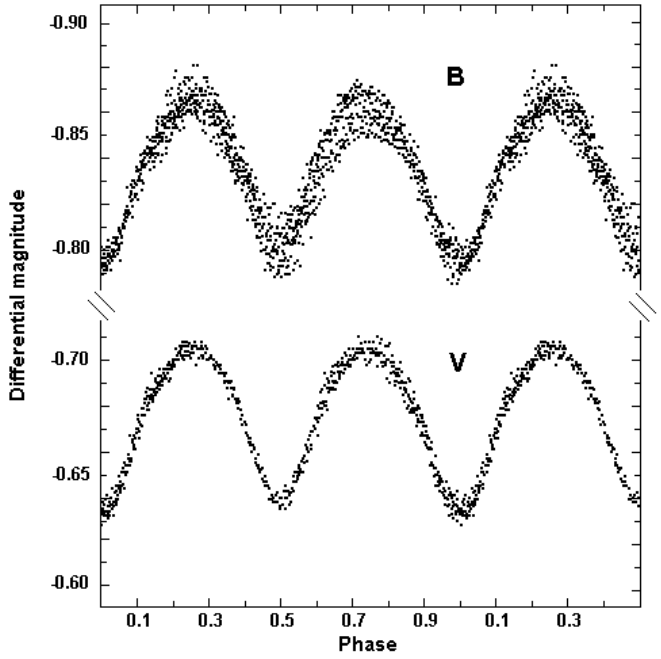

Figure 2. Differential B and V light-curves of V345 Gem

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ERRATUM FOR IBVS 5065

The coordinates for NSV 03007 given in IBVS 5065 are in error. The actual ones (2000), according to its identification with GSC 3376-0287 and SIMBAD database are:

$$\text{R.A.} = 06^{\rm h}32^{\rm m}46\overset{\rm s}{.}2$$
$$\text{Dec.} = +46^\circ 23' 32\overset{''}{.}82\,.$$

Enríque García-Melendo