DETECTION OF SUPERHUMPS IN THE DWARF NOVA PV PERSEI

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ABSTRACT. The CBA (Center for Backyard Astrophysics) Belgium Observatory belongs to a global network of small photometric telescopes, that study periodic phenomena in Cataclysmic Variables (CVs). This network is among the leading examples of successful partnerships between professional and amateur astronomers. In a few occasions, CBA stations operate on a stand-alone basis on some selected CVs. This paper reports the results of such an individual photometry campaign. The dwarf nova PV Per was observed for three nights during its outburst in September 1996 at the CBA Belgium Observatory. Unfiltered differential CCD photometry revealed superhumps with a period of 0.0805±0.0001 days. This finding establishes PV Per as being a new member of the SU UMa-type dwarf novae.

Key words: Stars: cataclysmic: PV Per

1. Introduction

The Center for Backyard Astrophysics (CBA) is a multi-longitude network of small photometric telescopes, owned by talented amateurs, who study periodic phenomena in Cataclysmic Variables (CVs). It is among the leading examples of successful partnerships between professional and amateur enthusiasts, producing vast amounts of high-quality variable star data.

Since 1991, the CBA network has been engaged in long-term photometric studies of CVs, primarily focusing on binary orbital periods, rotational periods, superhump periods and accretion disk precession periods. Target objects comprise SU UMa-type dwarf novae, intermediate polars (and DQ Her stars), permanent superhumpers (e.g., nova-like objects) and helium CVs, for which long, dense time-series differential photometry is performed.

Mentor of the CBA network is Columbia University astronomer Joe Patterson, who directs the collaboration and analyses the photometric CCD data. Participating observing stations are located in 6 continents and most are operated by dedicated amateur astronomers. The majority of the CBA "backyard" observatories allow robotic observations, meaning that all night long autonomous operation is guaranteed.

Target campaigns and results of the CBA are regularly reviewed on the CBA Web site (http://www.cba.http://www.astro.columbia.edu/).

2. The CBA Belgium Observatory

The CBA Belgium Observatory is located in Flanders, Belgium. The observatory building is a slide off roof structure, measuring 3m by 4m. Its primary instrument for CCD photometry is a computer controlled 25-cm f/6.3 Meade Schmidt-Cassegrain telescope on a permanent tripod. It is equipped with a SBIG ST-7 CCD camera (Kodak KAF-0400 CCD for imaging and Texas Instruments TC211 CCD for guiding) providing a field of view of approximately 15×10 arcminutes.

The observatory furthermore houses a laptop computer (Pentium P100), which controls all telescope and CCD operations:

- camera control and unfiltered photometric imaging are done using the CCDOPS software of SBIG. Images are stored as FITS files.

- telescope guiding is realised through a special software package, called "Star Track", written by the author. It updates the telescope position on a regular basis to keep it aligned on a reference star, and it continuously monitors sky conditions.

The described set-up allows all-night long autonomous and unattended operation. The only human interaction required is for opening and closing of the observatory, and initialisation of the telescope, camera and computers. This process takes between 10 and 15 minutes.

After an observing night, data reduction is done on a dedicated PC (Pentium P133), employing a commercial package for differential PSF (Point Spread Function) photometry. The final data analysis uses some special software written by the Belgian amateur astronomer Patrick Wils, who implemented routines for PDM (Phase Dispersion Minimization), a period determination technique developed by R.F. Stellingwerf (Stellingwerf, 1978).

3. Observations of PV Per during the September 1996 outburst

Although the CBA observatories primarily participate in multi-longitudinal coordinated campaigns on selected cataclysmic variables, individual initiatives are encouraged, especially if the latter deal with searching for superhumps in rarely outbursting dwarf novae. We report the results of such a successful individual campaign.

PV Persei is an UG (U Geminorum) type dwarf nova with a photographic magnitude range from mag 14.9 to mag 20:. It is located at R.A. $=02^h42^m53.57^s$, Decl. $= +38°04'02.6''$ (J2000.0).

An archive study of the Sonneberg plate collection revealed that PV Per had rather frequent outbursts (Busch and Haeussler, 1979). A detailed analysis of these outburst data already indicated the existence of both short, faint outbursts and long, bright outbursts. The latter showed an initial slow decline, followed by a 1 mag d-1 brightness drop, suggesting the possible SU UMa-type nature of this object.

The first positive detection of PV Per during its September 1996 outburst was visually made by amateur astronomer Eric Broens, Belgium on 1996 September 15.924 UT (Vanmunster, 1996). Since the object was part of an alert programme on little studied cataclysmic variables (Vanmunster, 1997), set up by the Variable Star Section of the Belgian Astronomical Association, other amateurs were immediately notified of the ongoing outburst, through the Cataclysmic Variables Circulars. These electronic circulars are distributed to over 30 amateur and professional astronomers all over the world.

The CBA Belgium observatory was the first to confirm the ongoing outburst and instantaneously started unfiltered differential CCD photometry, which was again repeated on the following two nights. The resulting light curve is shown in figure 1.

Observations were carried out with the equipment described above. We used $2 \cdot 2$ on-chip summation, with exposure times of 180 sec and a dead-time of 10 sec throughout the observations. All frames were corrected for standard debiasing and flat-fielding. The differential magnitudes were derived using a primary comparison star (GSC 2845 1482, mag 12.3) located approximately $1.1'$ SE of the variable.

At the time of our first run on September 15, 1996, superhumps had already clearly developed (see figure 1), with a semi-amplitude of 0.18 magnitude. This finding established PV Per as a new member of the SU UMa-type dwarf novae. The humps showed a steep rise and gradual decline, which is characteristic for SU UMa-type dwarf novae early in their development of superhumps.

We made 196 photometric observations at CBA Belgium Observatory, between September 15-17, 1996. After heliocentric correction and after subtracting a linear trend of decline, we used the Phase Dispersion Minimization

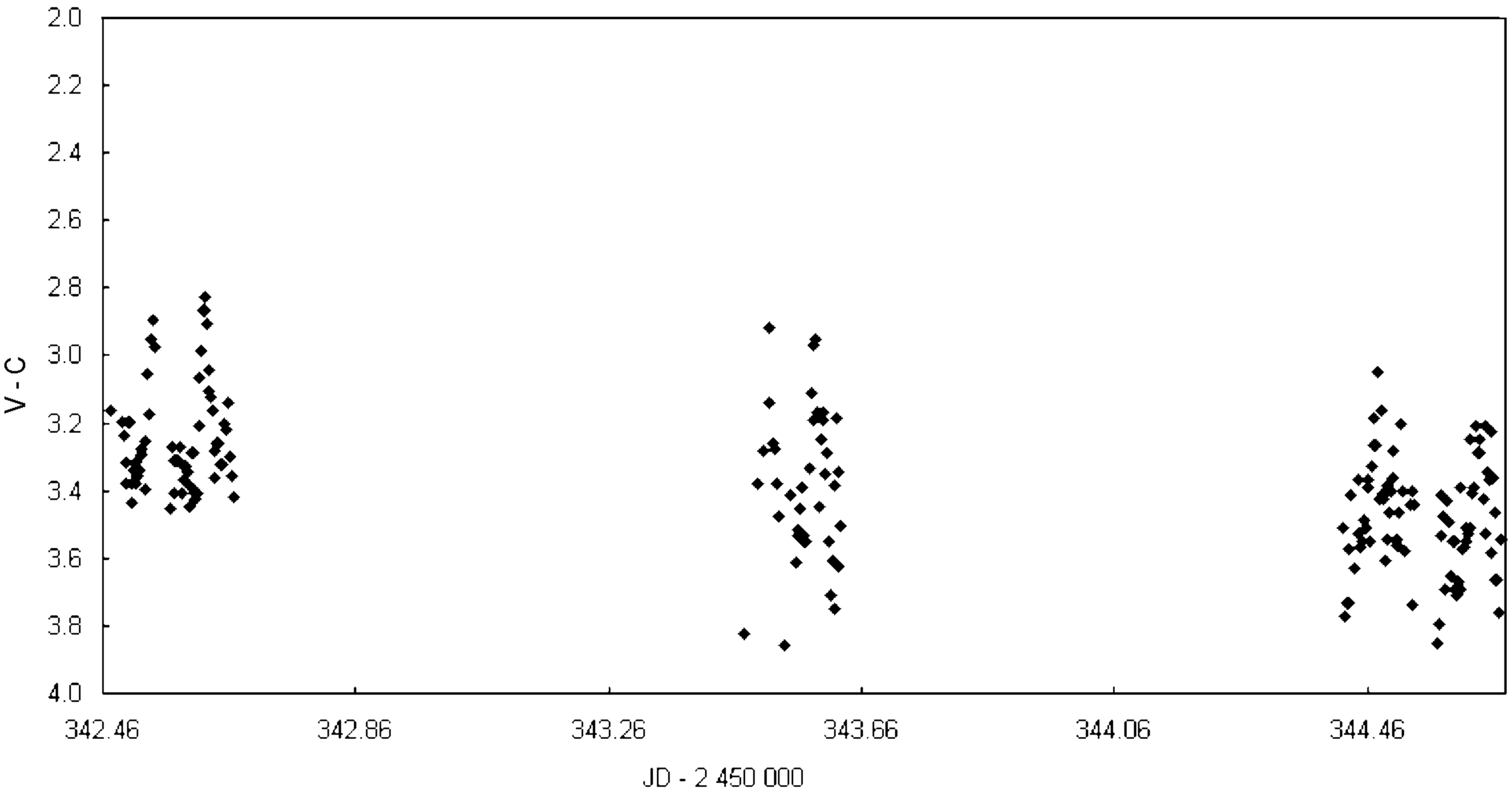

Figure 1. Overall unfiltered light curve of PV Per during the September 1996 outburst. V-C is the difference between PV Per and the comparison star. The primary features in the light curve are the superhumps.

(PDM) method to derive a superhump period of 0.0805 ($\pm$ 0.0001) day.

Our superhump observations and superhump period value were confirmed by Taichi Kato and his team, observing at Ouda Observatory, Kyoto University, Japan during the nights of September 16-18, 1996. He derived a superhump period of 0.0804 day (Kato, 1996).

Further observations to determine more precise outburst characteristics and the supercycle length are highly desirable.

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