Backyard Research on Cataclysmic Variables by a Consortium of Professional and Amateur Astronomers: DV UMa—A Case Study

Tonny Vanmunster
Center for Backyard Astrophysics, Walhostraat 1A, B-3401 Landen, Belgium

Abstract 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). The CBA is among the leading examples of successful partnerships between professional and amateur enthusiasts, producing vast amounts of high-quality variable star data. This poster paper highlights observational CBA results obtained on DV UMa, a most interesting eclipsing UGSU-type dwarf nova, that has been intensively monitored during its April 1997 superoutburst.

1. Mission of the Center for Backyard Astrophysics

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 UGSU-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.

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

Typically after a period of one to two years, the photometric data on a given campaign star reach a critical mass, which warrants publication in professional literature (*PASP*, *ApJ*, and others).

2. The CBA campaign on DV UMa

This paper highlights some (preliminary) photometric CBA results obtained on DV UMa during its April 1997 superoutburst.

DV UMa (= US 943) was discovered by Usher *et al.* (1981) as an ultraviolet excess object at a high galactic latitude. The object was subsequently identified by Howell *et al.* (1988) as an eclipsing CV at high inclination, with typical eclipses being 1.5 magnitudes deep and lasting only 12 minutes. He derived an orbital period of 0.08597d ± 0.00001d, and found no evidence that the eclipse depth varied with time. During the 1995 outburst of this object, Kato (1995) revised the orbital period and found a value of 0.08585d ± 0.00001d. He furthermore reported asymmetric eclipses, with an amplitude of approximately 4 magnitudes and a duration of nearly 13 minutes.

DV UMa was again detected in outburst in April 1997 by amateurs Timo Kinnunen (Finland) and Tonny Vanmunster (Belgium). Visual and CCD observations published in the Cataclysmic Variables Circulars indicated that the object declined at a rate of 0.11 magnitude per day during the first eight days of the outburst, after which a much faster decline at approximately 0.8 magnitude per day was noticed.

The 1997 outburst of DV UMa was very intensively monitored by the CBA network, yielding over 100 hours of photometric CCD coverage, resulting in nearly 9000 useful data points.

2.1. Orbital period determination

Our photometric data on DV UMa included nearly three dozen heliocentric eclipse timings, which allowed a further refinement of the published orbital period (Kato 1995). We derived a value of 0.085852619 d. Our data furthermore revealed an average eclipse duration of 14 minutes and an eclipse depth that evidently varied in time (see section 2.3.).

2.2. Superhump period determination

Shortly after the outburst announcement, the Belgian CBA station detected superhumps in the light curve of DV UMa. This established—for the first time—the UGSU-type nature of this dwarf nova, making it one of the few superhumping dwarf novae that also show eclipses.

In this first stage of the outburst, a superhump period of 0.0892d ± 0.0004d was derived, having a superhump amplitude of about 0.35 magnitude (unfiltered photometry).

2.3. Accretion disk precession period

Figure 1 is a two-day light curve of DV UMa during its April 1997 superoutburst. It shows the major features of this object—strictly periodic eclipses and superhumps—among others. It also indicates a modulation of eclipse depths and superhump amplitudes that is again present in the 20-day CBA light curve of this object.

We attribute this modulation to the beat period of the system, i.e., the precession period of the eccentric accretion disk, which is determined by:

$$P_{beat} = \frac{P_s P_{orb}}{(P_s - P_{orb})}$$

where P_s = superhump period, P_{orb} = orbital period, P_{beat} = beat period. The theoretical beat period, derived from the above formula, is approximately 2 days, which corresponds well with the observed modulation.

3. Conclusion

We have described the stellar photometry research program of the CBA network, and have presented observational results on the UGSU+E-type dwarf nova DV UMa. We derived an improved orbital period value, detected superhumps, and found observational evidence for modulation of eclipses and superhump amplitudes with the beat period. CBA objectives and results are regularly reviewed on our Web site at www.cbabelgium.com.

References

Howell, S. B., Warnock, A., Mason, K. O., Reichert, G. A., and Kreidl, T. J. 1988, *Mon. Not. Roy. Astron. Soc.*, **233**, 79.

Kato, T. 1995, Variable Star Network (VSNET) Electronic Alert Message.

Usher, P. D., Mattson, D., and Warnock, A. 1982, *Astrophys. J., Suppl. Ser.*, **48**, 51.

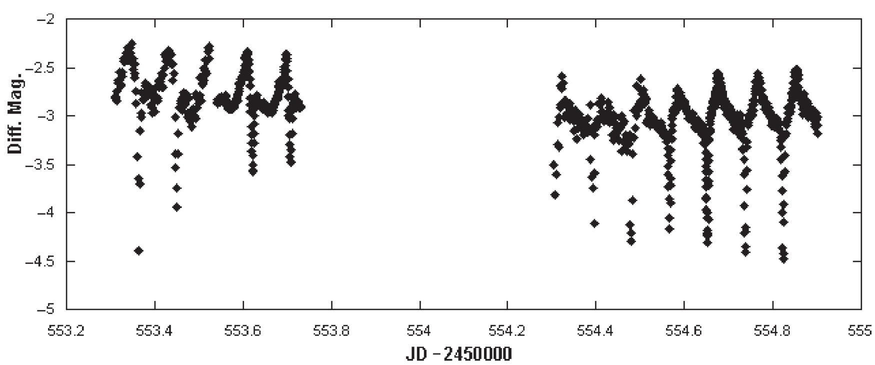

Figure 1. Two-day light curve of DV UMa during its April 1997 superoutburst.