ONE-METER TELESCOPE IN KOLONICA SADDLE - 4 YEARS OF OPERATION

I. Kudzej[1], P.A. Dubovsky[2]

[1] Vihorlat Astronomical Observatory Humenne, Slovakia, *vihorlatobs1@stonline.sk*
[2] Vihorlat Astronomical Observatory Humenne, Slovakia, *var@kozmos.sk*

ABSTRACT. The actual technical status of 1 meter Vihorlat National Telescope (VNT) at Astronomical Observatory at Kolonica Saddle is presented. Cassegrain and Nasmyth focus, autoguiding system, computer controlled focusing and fine movements and other improvements achieved recently. For two channel photoelectric photometer the system of channels calibration based on artificial light source is described. For CCD camera FLI PL1001E actually installed in Cassegrain focus we presents transformation coefficients from our instrumental to international photometric BVRI system. The measurements were done during regular observations when good photometry of the constant field stars was available. Before FLI camera acquisition we used SBIG ST9 camera. Transformation coefficients for this instrument are presented as well.

In the second part of the paper we presents results of variable stars observations with 1 meter telescope in recent four years. The first experimental electronic measurements were done in 2006. Both with CCD cameras and with two channel photoelectric photometer. Starting in 2007 the regular observing program is in operation. There are only few stars suitable for two channel photoelectric photometer observation. Generally the photometer is better when fast brightness changes (time scale of seconds) must be recorded. Thus the majority of observations is done with CCD detectors. We presents an brief overview of most important observing programs: long term monitoring of selected intermediate polars, eclipse observations of SW Sex stars. Occasional observing campaigns were performed on several interesting objects: OT_J071126.0+440405, V603 Aql, V471 Tau eclipse timings, Z And in outburst.

Key words: Stars: binaries: cataclysmic, eclipsing; Telescopes; stars: individual: Z And, V603 Aql, TT Ari, VW Ari, MU Cam, BG CMi, V471 Tau.

1. Introduction

Vihorlat National Telescope (VNT) is the main instrument of The Astronomical Observatory at Kolonica Saddle. Its main parameters are listed below.

Table 1: Main technical parameters

Main mirror diameter	= 1000 mm
Cassegrain focus focal lenght	= 9000 mm
CCD camera FLI PL1001E,	
Pixel scale with binning 2x2:	1 px = 1.10 arcsec

The telescope can work in 4 different operational modes:

- PEP - photoelectric photometry in Cassegrain focus and autoguiding through photometer.
- CCD photometry in Cassegrain focus and autoguiding on Pointer telescope.
- CCD photometry with Pointer telescope, simultaneous photoelectric photometry and autoguiding in Cassegrain focus of VNT.
- Visual observation in Nasmyth focus.

The detailed description of the telescope and detectors can be found in Kudzej et al. 2007.

2. Description of the instrument

2.1. Differential photometry with 2 channel photometer

The typical observing run looks as follows: Automatic sky measurement through diaphragm with diameter 30 arcsec every 100 - 200 exposures. The number of exposures is generated randomly in the range stated by observer. Star measurements through diaphragm #3 - diameter 40 arcsec. Exposure time 10 sec. Filter B, V or R. Calibration on constant star only in good photometric nights. Calibration on artificial light source (diode) during the observing run 3 - 5 times.

Typical serie:
5K,[5Vsky, 100-200Vstar,5Vsky]..... [5Vsky, 100-200Vstar,5Vsky],5K.

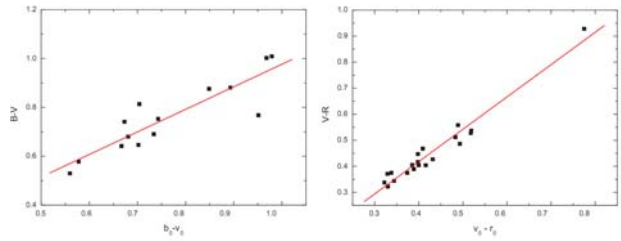

Figure 1: Dependency of (b - v) vs. (B - V) and (v - r) vs. (V - R) for combination of VNT and FLI camera. Observations made in January 2010.

2.2 Autoguiding system

Autoguiding of the VNT is carried out by TV Guider constructed by M. Myslivec from Czech Republic.

2.3 Autofocusing

The possibility of remote control of focusing has big impact on quality of observation. We have focusing system based on synchronous motors on secondary mirror of VNT. The control is carried out by the same software we control the CCD camera - Maxim DL.

2.4 Transformation coefficients for CCD photometry

We use transformation equations: V = v + ζ_v(B - V) B - V = ζ_{bv}(b - v), V - R = ζ_{vr}(v - r), where we denote b, v and r above-atmosphere instrumental magnitudes for used filters and B, V and R corresponding standard magnitudes. The following results were obtained analyzing images obtained during regular observations of enigmatic polar OT J071126.0+440405. Values of standard stars are from Henden's photometry (Henden & Honeycutt 1995).

Table 2: Weighted transformation coefficients with errors in parenthesis for BVR filters for used combinations of telescopes and CCD cameras.

Instrument	ζ_v	ζ_{bv}	ζ_{vr}
Pointer+FLI	0.002(8)	0.993(24)	1.005(19)
VNT+SBIG ST9	0.004(12)	0.991(29)	0.993(17)
VNT+FLI	0.001(7)	0.994(24)	1.007(17)

3. Observing results with two channel photoelectric photometer

3.1. Asteroseismology with 2 channel photometer

In 2007 we have performed campaigns on two low amplitude Delta Scuti type pulsating variables V2314 Oph and VW Ari. Our results were compared with the light curves and frequency patterns from the other observatories and presented at Kolos conference in 2007.

3.2. High time resolution photometry of TT Ari

There are rapid brightness variations in the active state of this cataclysmic star. We made 5 observations with 2 channel photometer on VNT with time resolution 1 second during the autumn 2007. One observation was simultaneous measurements with VNT (Photometer) and Pointer (CCD camera) telescopes.

4. Observing results - CCD photometry

4.1. Inter-Longitude Astronomy (ILA) long term monitoring of intermediate polars

The goal of the campaign is to monitor the selected intermediate polars for spin period changes (Andronov et al. 2003). Detailed data analysis is done by Prof. Andronov team including data from Korea, Crimea and USA. The list of targets is in the Table 3.

Table 3: Selected targets of the Interlongitude Astronomy monitoring

Star	P_{orb}[min]	P_{spin}[sec]	V
RXJ2133.7+5107	431.58	571	16.0
MU Cam	283.12	1187	15.0
BG CMi	194.04	913	14.5
PQ Gem	311.56	834	14.0
1RXS J063631.9 +353537	201	1008	17.0
1RXS J070407.9 +262501	250	481	17.0
DO Dra	238.14	528	14.5
V795 Her	155.88	950?	12.5
1RXS J180340.0 +401214	160.21	1520.51	17.0
1RXS J192626.8 +132153	291?	938.6	18.0
FO Aqr	290.96	1254.284	14.0
AO Psc	215.46	805	14.0
V603 Aql permanent superhumper	198.85	-	12.0
V1432 Aql asynchronous polar	201.94	202.50 min	12.0

Some interesting results up to now are depicted in figures 2 - 5.

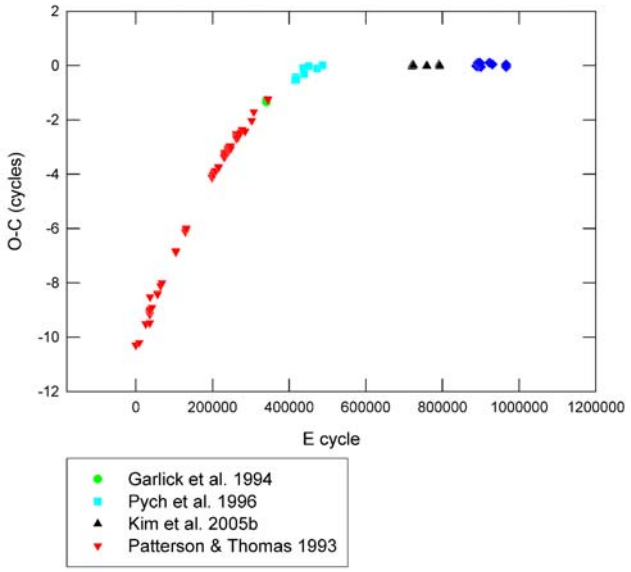

Figure 2: **BG CMi**. O-C diagram of pulse maxima calculated with the linear ephemeris $HJDmax = 2453105.31448 + 0.01057257716 \times E$. Cycle counting according Kim et al. 2005b. DPV means observations made by co-author P.A.D with VNT.

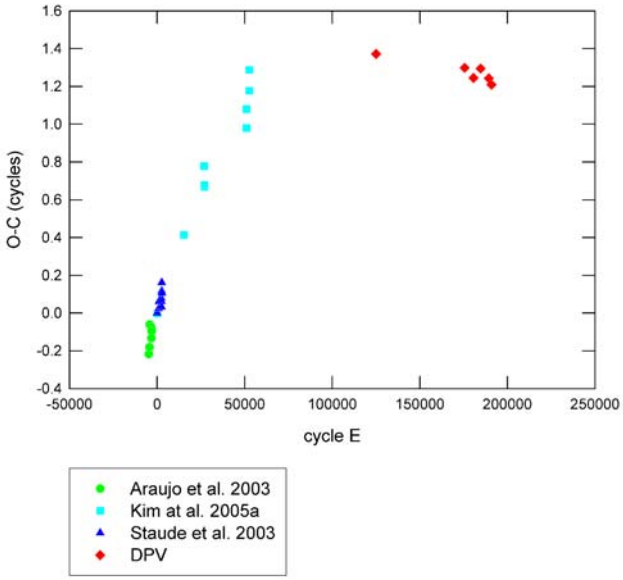

Figure 4: **MU Cam** = 1RXS J0625+7334. O-C diagram of pulse maxima calculated with the linear ephemeris: $HJDmax = 2452682.4181 + 0.0137408 \times E$. - 1 cycle after E=26826.

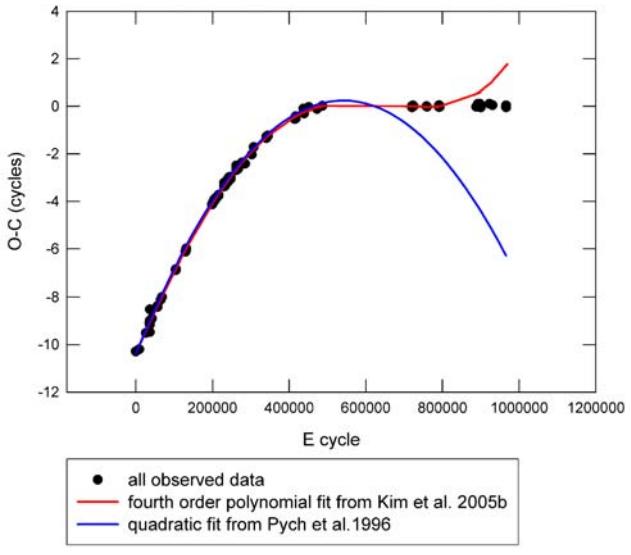

Figure 3: **BG CMi**. Comparison with previously published models. No one from previously published quadratic, cubic or even fourth-order polynomial ephemeris fits new data.

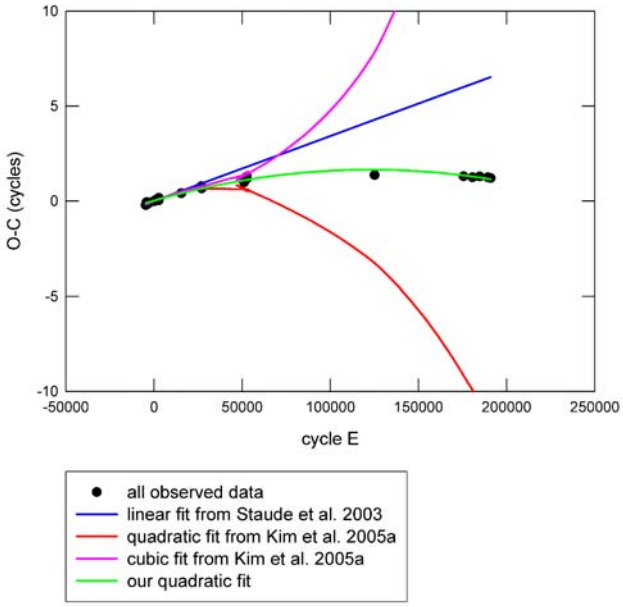

Figure 5: **MU Cam**. Comparison with previously published models.

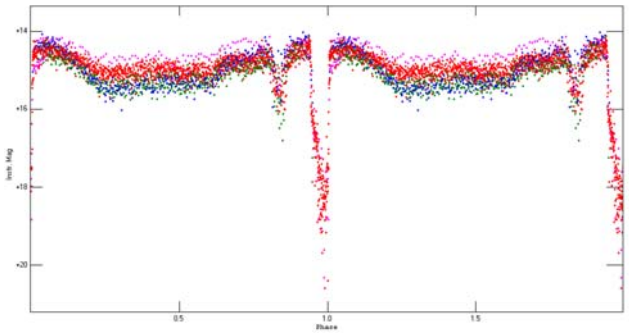

Figure 6: *OT_J071126.0 + 440405*. Folded light curve. Different color corresponds to different filter used.

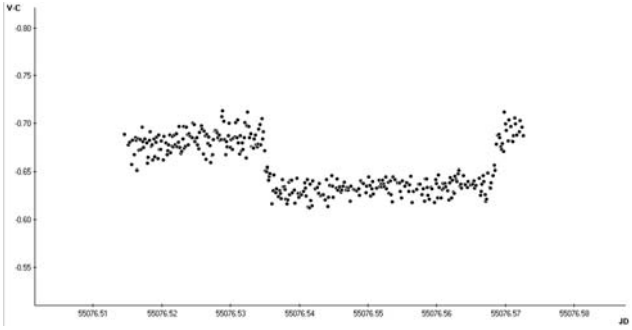

Figure 7: **V471 Tau**. 20.08.2009.

4.2. Inter-Longitude Astronomy campaign OT J071126.0+440405

This object was discovered in January 2009 by Catalina Sky Survey (Drake et al. 2009) as relatively bright polar with deep eclipses. In the active state there is a pre-eclipse dip at phase -0.13 interpreted as eclipse caused by accretion stream falling toward white dwarf. Total 3 types of eclipses and 3 distinctly separate luminosity states were observed during the intense observing campaign during the spring 2009.

4.3. V603 Aql

In the summer 2009 N. Virnina carried out observing campaign with VNT on this nova like variable. Total 14 light curves with R and V filter interchanged. Rapid brightness variations were covered with 30 s time resolution. No important color variations were observed.

4.4. Eclipse mapping of SW Sex stars

The SW Sextantis stars compose a group of nova-like cataclysmic variables. The main goal of observing program proposed by A. Halevin (Odessa) is to observe the shape of the eclipse and to model the accretion disc using eclipse mapping method. Our list of observed eclipsing systems:

- LX Ser
- TT Tri
- HS0455+8315
- HS0728+6738

4.5. Z And

The prototype of symbiotic stars showed low amplitude irregular variations during autumn 2009 outburst. We have collected 5 light curves with VNT or Pointer telescopes in B, V, and Rc filters.

4.6. V471 Tau

Eclipsing pre cataclysmic system with eclipses observable only in U and B filter. The start and the end of

eclipse is very sharp. So we needed good time resolution. We used exposure time 10 s in B filter. Our results confirmed sinusoidal character of O-C diagram.

Acknowledgements. The work was supported by the Ukrainian MON grant No M/153-2006 and the Bilatelar APVV grant SK-UK-01006, as also the Grant of the Slovak Research and Development Agency LPP-0049-06 and LPP-0024-09 and The National Scholarship Programme of the Slovak Republic. SBIG ST9 camera was kindly provided by K. Petrik from Hlohovec Observatory.

References

Andronov I.L., Antoniuk K.A, Augusto P., et al.: 2003, *As. Ap. Transact.,* **22**, 793.

Araujo-Betancor S., Gaensicke B.T., Hagen H.J., et al.: 2003, *A&A*, **406**, 213.

Drake A.J., Djorgovski S.G., Mahabal A., et al.: 2009, *ApJ*, **696**, 870.

Garlick M.A., Rosen S.R., Mittaz J.P.D., et al.: 1994, *MNRAS*, **267**, 1095.

Henden A.A., Honeycutt K.T.: 1995, *PASP*, **107**, 324.

Kim Y., Andronov I.L., Park S.S., et al.: 2005, *JA&SS*, **21**, 191.

Kim Y., Andronov I.L., Park S.S., et al.: 2005, *JA&SS*, **22**, 197.

Kudzej I., Karetnikov V.G., Dubovsky P.A., et al.: 2007 *OAP,* **20**, 100.

Patterson J., Thomas G.: 1993, *PASP*, **105**, 59.

Pych W., Semeniuk I., Olech A., et al.: 1996, *AcA*, **46**, 279.

Staude A., Schwope A.D., Krumpe M., et al.: 2003, *A&A*, **406**, 253.