J. Astrophys. Astr. (2002) **23,** 15–18

The Investigation of Nova-like Variable MV Lyr during the 1999–2001 Years

N. A. Katysheva & S. Yu. Shugarov[1], E. P. Pavlenko[2] & P. V. Abolmasov[3]

[1] *Sternberg Astronomical Institute, Moscow, Russia.*
[2] *Crimean Astrophysical Observatory, p. Nauchny, Crimea.*
[3] *Physical Department, Moscow State University, Moscow, Russia.*

Abstract. A peculiar nova-like MV Lyr was investigated. The CCD-observations of MV Lyr were continued in Crimea during the outbursts and quiescent states. Last year its behavior became non-typical for "anti-dwarf novae". The length of its first deep minimum was 10 years. A modern state is characterized by very strong outbursts and very often changes of the stages. The periods $0.^{d}128$ and $0.^{d}136$ were obtained for 1998 and 1999 years accordingly. Possibly, a relation between the photometric period and the brightness exists.

Key words. Cataclysmic variables—"anti-dwarf novae".

1. Introduction

MV Lyr is one of the brightest cataclysmic variables of the northern sky. It was discovered by Parenago (1946) in 1946 as a star with an irregular variability. Later it was classified as nova-like subtype star – the VY Scl-star, or "anti-dwarf nova". In the years 1979–1989 this star similar to other "anti-dwarf novae" spent its time in a high brightness state ("on" stage, $B \simeq 12.^{m}5$), getting weaker by 2^{m}–8^{m} sometimes ("off" stage, $B \simeq 18^{m}$) and returning to the "on" stage. But later its behaviour became non-typical for indicated stars. The length of its first deep minimum was 10 years. In this state the outburst amplitude was 1^{m}–4^{m}. The main characteristic of its variability is the relatively stable sets in the high and low states with the amplitude about 5 magnitudes. The detailed description of the long-term photometric behaviour during 1951–1996 is presented in review by Pavlenko & Shugarov (1998) and some parameters of the system are in Highly Evolved Close Binary Systems Catalog (Cherepashchuk *et al.* 1996). The outbursts in 1997 were described in Pavlenko & Shugarov (1999) and some 1998–1999 ones in Katysheva *et al.* (2001).

The appearance of nova-like stars and particularly, MV Lyr in the high brightness state is an unpredictable event: our experience has shown that the brightness of "ordinary" outbursts never reaches the brightness of the real "high" state in MV Lyr. Even the most powerful outbursts are fainter than high state on 0.5 mag. Since 1994 MV Lyr changed its style of behaviour into a controversial one and we had already started to hunt for the real "prolonged high" state. So when in 1998 the brightness of MV Lyr had jumped above the level, which distinguishes the outburst from the "real" high state, we started the multilongitude photometric campaign. Its results (1998–1999 observations) are present in Katysheva *et al.* (2001). Last two years we continued to study the behaviour of MV Lyr in B, V, R, I-bands.

2. Observations

Observations of the years 2000–2001 have been carried out at the Zeiss-600 and ZTE 1.25-m telescopes of the Crimean Laboratory of the Sternberg Astronomical Institute, at the 38-cm telescope of the Crimean Astrophysical Observatory and at the Newton 30-cm telescope of the SAI Student Observatory (Moscow). The light detectors were CCD-cameras: ST-6, ST-7 and ST-8. Observations were in R-band of the Johnson system with time resolutions 1.5–3 minutes. The dead times between exposures were 15sec and in total we obtained several hundred measurements over 30 nights in Moscow and in Crimea (1999–2001: JD 2451522–52230). The comparison stars were used from Pavlenko & Shugarov (1999).

The light curve of MV Lyr over the last 25 years was shown in Katysheva *et al.* (2001). The light curve of the last four years is present in Fig. 1 (1998–2001), it is plotted (R-band) according to our data.

Over the first "low" state (1979–1989) MV Lyr has shown the sequence of relatively short dwarf-like outbursts of different amplitudes and durations (see Pavlenko & Shugarov 1998), that are superposed on the level of quiet state ($B \sim 17.^m5$). In 1989 this state rapidly changed on the high one ($B \sim 12.^m5$), that lasted till 1995. Then MV Lyr entered into the state that is different from the previous states: it displayed a sequence of strong outbursts of near equal amplitudes ($4^m - 5^m$), that were larger then those of the most strong outbursts of the first low state. Over our campaign (1999–2001) MV Lyr displayed possibly three or four bright outbursts.

The question of the light variations in the vicinity of the orbital period is still puzzling. The spectral observations by Schneider *et al.* (1981) and Skillman *et al.* (1995) gave the $P_{\rm orb} = 0.^d133$. The photometric behaviour has been studied by several

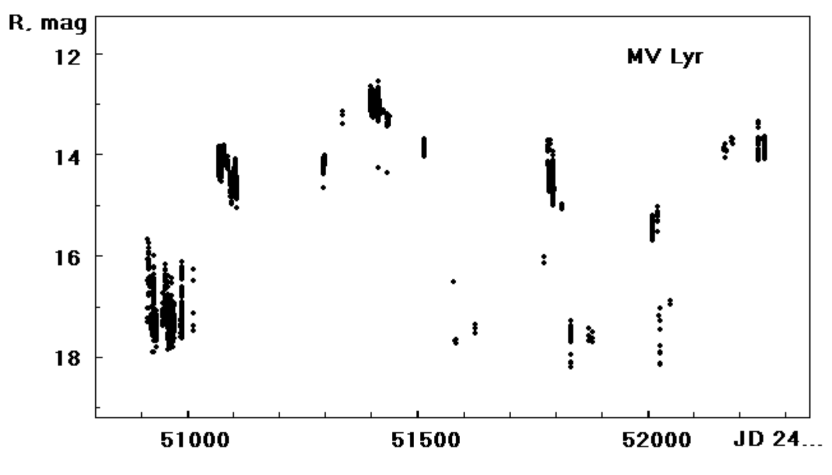

Figure 1. The overall light curve of MV Lyr during 1998–2001. The magnitudes R are plotted versus Julian date.

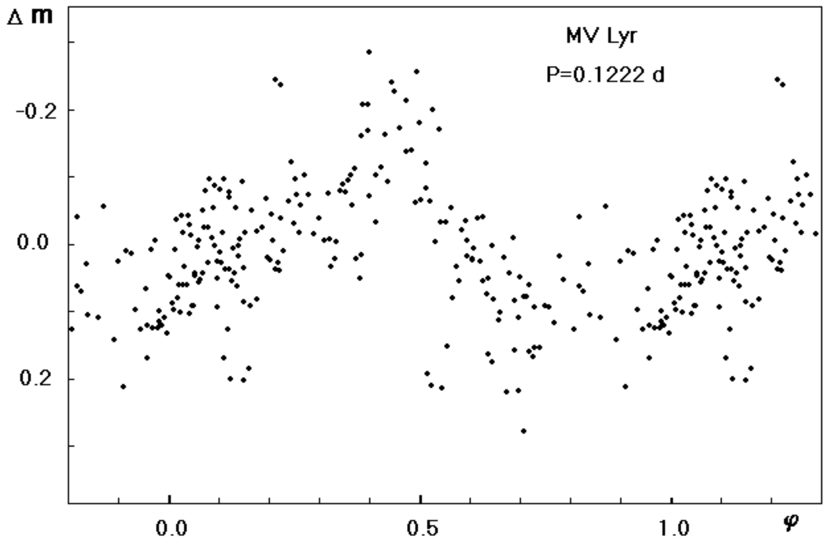

Figure 2. The data folded on the period 0.1222d (2001).

authors, but there was no simple result. Borisov (1992) and Skillman *et al.* (1995) observed this star at a high level of brightness and found the period $0.^d138$. This value is somewhat larger than the spectroscopic period and was interpreted as possible positive superhumps. Pavlenko & Shugarov (1998) found the most likely light variations of $0.^d1294$ (or $0.^d1487$). The first one seemed to be more preferable as it was close to that for known negative superhumpers. The second period was less likely because it was placed far above the known empirical relation between the fractional period excess $(P_{sh}–P_{orb})$, where P_{sh} and P_{orb} are the superhump and orbital periods respec-

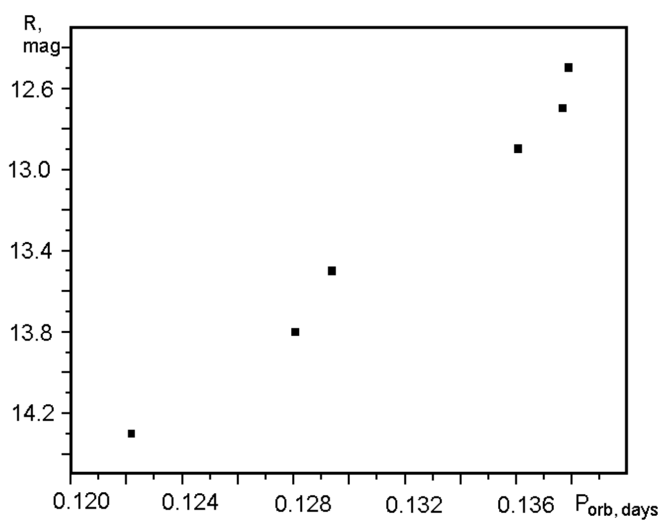

Figure 3. The magnitude versus period for MV Lyr.

tively (Stolz & Schoembs 1984). Our observations of 1998–1999 during two outbursts (Katysheva *et al.* 2001) give for 1999 the most likely period – $0.^{d}1361$ and for 1998 – $0.^{d}1281$.

We gathered all available data on the finding of the near-orbital light variations and plotted them against the brightness of MV Lyr. The result was given in Fig. 4 (Katysheva *et al.* (2001). It was seen that the photometric period decreases when the brightness decreases. Our conclusion was: a possible relation between the brightness state and the photometric period exists! Obviously it cannot be caused by the known decreasing of the superhump period for the SU UMa stars over the course of the superoutburst: the scale of the superhump period decrease is much smaller. We found the most likely light variations of $0.^{d}1222$ (or $0.^{d}139$). The first one seemed to be more preferable as it was close to that for known negative superhumpers. The relation "brightness–photometrical period" is present in Fig. 3. A point $0.^{d}1222$ lies on the indicated line.

The following observations of this peculiar nova-like star are strongly recommended for the study of this relation.

Acknowledgement

This work was supported by RFBR grants 00-15-96553, 00-02-16471, 01-02-27244 and "University of Russia". NK is grateful to SOC and LOC for the possibility to participate in this meeting.

References

Borisov, G. V. 1992, *A& Ap*, **261,** 154.
Cherepashchuk, A. M. *et al.* 1996, *Highly Evolved Close Binary Stars.* Catalog./ (ed) A. M. Cherepashchuk (Brussel: Gordon & Breach Science Publ.)
Katysheva N. A. *et al.* 2001, *Kinem. Physics Celect. Bodies, Suppl.* **3,** 393.
Parenago, P. P. 1946, *Perem. Zvezdy* (Variable Stars), **6,** 26.
Pavlenko, E. P., Shugarov, S. Yu. 1998, *As. Ap. Trans.* **15,** 89.
Pavlenko, E. P., Shugarov, S. Yu. 1999, *A & Ap*, **343,** 909.
Schneider, D. P. *et al.* 1981, *ApJ*, **245,** 644.
Skillman, D. R. *et al.* 1995, *PASP*, **107,** 545.
Stolz, B., Schoembs, R. 1984, *A& Ap*, **132,** 187.