MV Lyr: TRANSITION FROM LOW TO HIGH BRIGHTNESS STATE

ELENA PAVLENKO[1], KIRILL ANTONIUK[1], SERGEI YU. SHUGAROV[2],
NATALY A. KATYSHEVA[2], LENIE MUZHDABAEVA[3]
and VYACHESLAV MIKHAJLOV[4]

[1]*Crimean Astrophysical Observatory, Nauchny, Crimea 98409, Ukraine;*
E-mail: pavlenko@crao.crimea.ua
[2]*Sternberg State Astronomical Institute, Universitetskij Prosp. 13, Moscow 119992, Russia*
[3]*Tavrichesky National University, Crimea 95007, Ukraine*
[4]*Simferopol Society of Amator Astronomers, Ukraine*

(accepted April 2004)

Abstract. We present results of multicolour photometry of the nova-like binary MV Lyr in the years 2002–2003, corresponding to the transition of the star from its low ($V = 17.8$) to high ($V = 12.3$) brightness state. The transition lasted at most 200 days. During the first ∼50 days MV Lyr brightened at the rate 0.06 mag/day, and during the next ∼150 days at the rate 0.01 mag/day. The brightening was accompanied by a blue shift from 0.45 to 0.05 in $V - R$, interpreted as an increase of the accretion disk contribution to the total light. During the transition MV Lyr displayed well-known 'quasi-orbital' light variations and fast quasi-periodic oscillations with a typical time scale of tens of minutes.

Keywords: stars, binaries, MV Lyr

1. Introduction

For long MV Lyr was thought to belong to the VY Scl-type stars or "anti-dwarf novae", which mostly remain in a high brightness state and abruptly fall to a faint state for a short time. However, our idea of this binary changed as the sporadic observations were replaced by systematic ones during the last 25 years. In 1979 MV Lyr entered a minimum and spent there 10 years. In that state it showed relatively short outbursts of amplitude 1^m–4^m and duration of 7–100 days. In 1989–1995 MV Lyr was in a high state (the 25-year light curve is shown in Katysheva et al., 2000). The next low state lasted nearly 7 years. No orbital light variations have been found in the faint state, while in the high and intermediate states some observers detected light modulations close to the orbital period, but systematically different by several minutes (Borisov, 1992; Skillman et al., 1995; Pavlenko and Shugarov, 1999). In 2002 MV Lyr entered the high state. Here we present the results of multicolour observations of this star in 2002–2003.

2. Observations

Photometric observations of MV Lyr in 2002–2003 have been carried out at the Crimean Astrophysical Observatory (CrAO) and at the Crimean laboratory of the

Astrophysics and Space Science **296:** 461–464, 2005.

Sternberg Astronomical Institute (SAI) with different telescopes and equipment. $UBVRI$ (Johnson) observations were obtained with the 1.25 m telescope AZT-11 (CrAO) using the double beam chopping photometer/polarimeter designed by Korhonen and Piirola (1984); BVR (Johnson) observations were obtained using the CCD SBIG ST7 camera at the K-380 telescope (CrAO) and the Zeiss-600 telescope (SAI).

3. Results

We collected observations of MV Lyr covering the transition from low (faint) state, when the variable was at $V = 17.8$, to high (bright) brightness state ($V = 12.3$). The light curve and $V - R$ behaviour are shown in Figure 1. The photoelectric data are marked by open symbols. One could see that the brightening of the star occurred in two steps: the fast brightening lasted at most 50 days and had a rate of $\sim$0.06 mag/day; it was followed by a 6-times slower rate of 0.01 mag/day, which lasted $\sim$150 days. The star became more blue during its brightening. Figure 2 displays the behaviour of MV Lyr in the magnitude-colour diagram. $V - R$ changed from $\sim$0.45 in minimum to 0.05 in maximum with a ratio of $(V - R)/R = 0.03$. The V, $V - R$ dependence looks roughly linear, but there are some additional short-term light and colour variations (Andronov and Antonyuk, 2004). An example of two nightly light curves is displayed in Figure 3. They show variability on a scale of several hours – so-called "quasi-orbital" variations (Andronov et al., 1992) and decades of minutes.

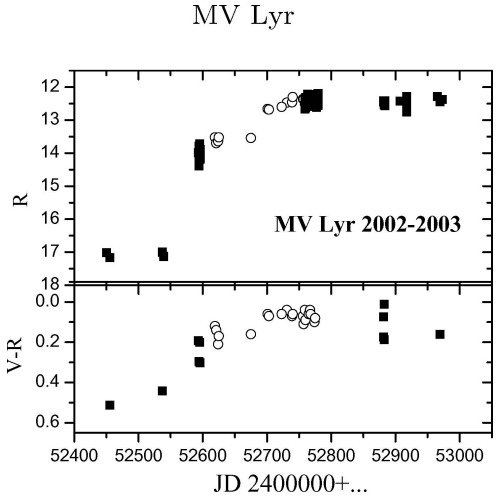

Figure 1. Light and $V - R$ curve of MV Lyr during transition from low to high brightness state.

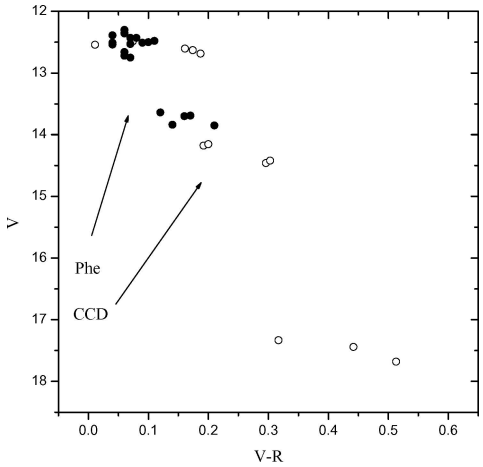

Figure 2. $V, V-R$ diagram for transition from low to high brightness state.

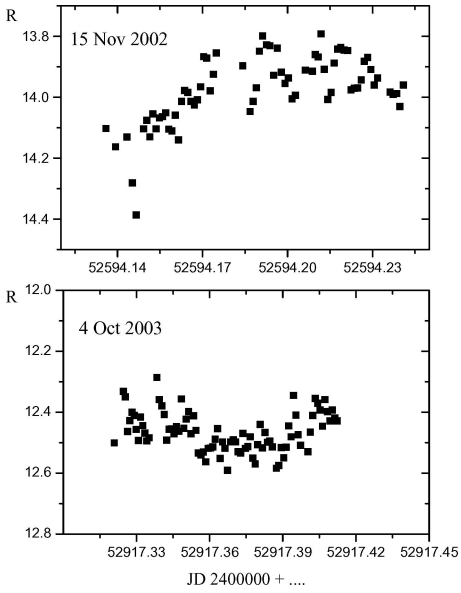

Figure 3. Two nightly light curves for intermediate and high brightness level.

4. Discussion: The Problem of the Orbital Light Modulation

The orbital period of MV Lyr was obtained by spectroscopy as 0.1336(17) days (Schneider et al., 1981) or 0.1329(4) days (Skillman et al., 1995). The search for a photometric orbital modulation was unsuccessful, perhaps due to the low binary inclination (10–13°). Only in the low state, when the disk contribution is less than

in the high state, a possible light modulation caused by the ellipsoidal effect or reflection effect could be expected. Recently Hoard et al., hereafter HLS (2004), reported on the absence of an accretion disk and evidence for a hot white dwarf (47 000 K) in the deep low state. Our $V - R$ measurement showed that in the faint state we observe light from both a white dwarf and a red dwarf in agreement with the HLS result. The blue shifting of $V - R$ simultaneously with brightening means an increased contribution of the accretion disk and a rise of its temperature. HLS predicted a high reflection effect in this close binary. At least two attempts were undertaken to search for and to confirm the orbital period by photometry during the last faint state (1995–2002). The first one was made at the beginning of the faint state in 1995–1996 in a broad "BV" system (Pavlenko, 1996), and the second one just prior to the high state in 2004 in V (HLS). The first attempt was unsuccessful, no indication of the orbital period was found. Very close to the orbital period a low-amplitude (less than 0.1 mag) modulation was detected at a period of 0.142 day. Meanwhile HLS found the photometric 0.1 mag modulation with an orbital period of $\sim$0.133 d, but its amplitude is much less than the predicted one. The authors explain this by the presence of star spots on the secondary component near the L_1 point and possible shadowing in the equatorial region of the secondary by the nascent accretion disk. Future observations in the faint state are necessary to study the orbital modulation appearance and disappearance and its connection with star spots and/or shadowing by the disk.

Acknowledgements

This work was partially supported by the Ukrainian Fund For Fundamental Researches 02/07/00451 and by the grants 02-02-16235, 02-02-17524 of Russian Foundation of Basic Researches and Russian President Grant NS-388.2003.3.

References

Andronov, I.L. and Antonyuk, K.: 2004, in astrophysics of Cataclysmic Variables and Related Objects, Hameury, H.M. and Lasota, J.P. (eds.), in press.

Andronov, I.L., Borodina, I.G., Chinarova L.L. et al.: 1992, *Soobsch. Spets. Astroph. Obs.* **69**, 125.

Borisov, G.V.: 1992, *A&A* **261**, 154.

Hoard, D.W., Linnell, A.P., Szkody, P. et al.: 2004, *ApJ* **604**, 346 .

Katysheva, N.A., et al.: 2000, *Kinemat. Phys. Celes. Bodies* **3**, 393.

Korhonen, T. and Piirola V.: 1984, ESO Messenger no.38, p. 20.

Piirola, V.: 1988, in Polarized Radiation of Circumstellar Origin, Coyne, G.V., Magalhaes, A.M., Moffat, A.F.J., Schulte-Ladbeck, R.E., Tapia, S., Wickramasinghe, D.T. (eds.), Vatican Observatory, p. 261.

Pavlenko, E.P.: 1996, *Odessa Astronom. Publ.* **9**, 38.

Pavlenko, E.P. and Shugarov S.Yu.: 1999, *A&A* **343**, 909.

Schneider, D.P., Young, P. and Shestman, S.A.: 1981, *ApJ* **245**, 644.

Skillman, D.R., Patterson, J. and Thorstensen, J.R.: 1995, *PASP* **107**, 545.