Observations of Some Unique Variable Stars At the Crimean Astrophysical Observatory

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Abstract The behavior of V404 Cygni, V1500 Cygni, MY Lyrae, and V1504 Cygni are investigated.

1. Introduction

We review both long-term (years) and short-term (hours and minutes) photometric behavior of several unique variable stars which have been observed using the Crimean Astrophysical Observatory's 0.5-m Meniscus telescope equipped with a TV system. Stars observed were: the black hole binary V404 Cyg, the magnetic nova V1500 Cyg, the nova-like binary MV Lyr, and the SU UMa dwarf nova V1504 Cyg.

2. Observations

2.1. V404 Cygni

V404 Cyg is the strongest black hole candidate among X-ray novae, with a mass function of 6.08 ± 0.06 $M_{\odot}$ for the optical star (Casares and Charles 1994), and an orbital period of 6.5 days (Casares *et al.* 1992). Our observations were carried out in a broad "B+V" region in quiescence during 1991–1996. Data show the ellipsoidal modulation, slow decreasing of mean binary light, and data scattering which indicates the existence of a six-hour light variation (Pavlenko *et al.* 1996).

2.2. V1500 Cygni

V1500 Cyg is the first recognized magnetic nova with asynchronous motion of components (Stockman *et al.* 1988). We continuously observed V1500 Cyg in the late stages of decline and in quiescence in the *V*-band. The analysis of brightness variations allowed us to discover the beat period between its unequal orbital period and its rotational period (Pavlenko and Pelt 1988), in order to find the rapid increase of the white dwarf spin period ($\dot{P}_{rot} = 1.8 \times 10^{-6}$) during the years 1977–1979, and subsequent reduction to $\dot{P}_{rot} = 2.7 \times 10^{-8}$ during the next ten years (Pavlenko and Pelt 1991; Pavlenko and Malanushenko 1996).

2.3. MV Lyrae

MV Lyr is a nova-like variable. It spends most of its time in a high brightness state (*B* ~12.5m). At the present time it is in a low state (*B* ~18m), sometimes showing outbursts up to (*B* ~13.5m). Outside of the outbursts, MV Lyr was rather

quiet. Only four nights out of forty showed either the single flashes which lasted 15–55 minutes, with an amplitude of 0.5 magnitude, or the sequence of flashes with an amplitude of 1 magnitude and a typical duration of 38 minutes.

2.4. V1504 Cygni

V1504 Cyg was suspected to be an SU UMa-type binary by Raykov and Yushchenko (1988). We carried out photometric observations of this binary during twenty-two nights in 1996. Two outbursts and one superoutburst were detected, with brightness changes from B = 18.5m to B = 13.6m. At minimum light three types of variability were seen: light variations of a few days with an amplitude of 0.7 magnitude; variations with one of three periods—2 hours, or 1 hour 50 minutes, or 1 hour 35 minutes; and variations having close to a 45-minute period.

In Figure 1, the overall and detailed behaviors of these four stars are shown.

3. Addendum, 2006

The SU UMa-type nature of the V1504 Cyg was confirmed later. Its superhump period is 0.072 day and the orbital one is 0.0695 day (Pavlenko *et al.* 2002). One of the most interesting peculiarities is the two-humped structure of the V1504 Cyg light curve in minimum. Thus observations with the 2.6-m Shajn telescope of CrAO in 2006 revealed the unequal humps of 0.6 and 0.4 magnitude in V (see Figure 2). The low-amplitude, short-term QPOs are superimposed on the orbital light curve.

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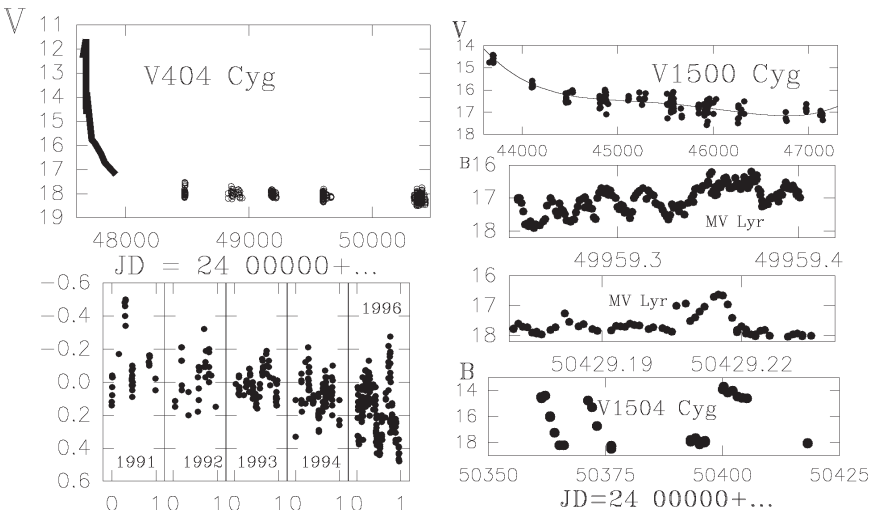

Figure 1. The light curves of V404 Cyg outburst and decline, V1500 Cyg decline, V1504 Cyg outbursts and superoutburst, and the behavior of MV Lyr during two selected nights in the low brightness stage. The brightness decline for V404 Cyg (solid line) is taken from numerical observations; our data are marked by circles. In the bottom panel, data folded on the orbital period are shown.

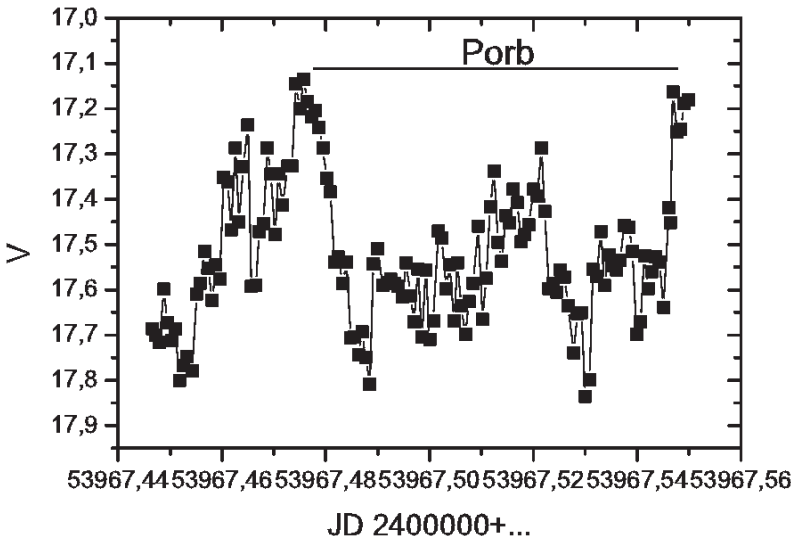

Figure 2. Light curve of V1504 Cyg showing a two-humped structure in minimum. The 2.6-m Shajn telescope of CrAO in 2006 revealed the unequal humps of 0.6 and 0.4 magnitude in *V*. The lesser-amplitude and short-term QPOs are superimposed on the orbital light curve.