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PHOTOMETRIC STUDY OF CLASSICAL NOVA V1674 Her

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An analysis of the new $UBVR_cI_c$ observations of V1674 Her obtained by the authors shows that the star is a very fast Nova, with parameters $T_2 = 1\overset{d}{.}1$, $T_3 = 2\overset{d}{.}2$. The orbital period at the brightness decline, 39–56 days after the outburst, was $0\overset{d}{.}15290$, the shape of the light curve featured two unequal minima separated by half a period, the amplitude of the observed wave being $0\overset{m}{.}12$.

1 Introduction

The variable star TCP J18573095+1653396 = V1674 Her (Kazarovets et al., 2021) was discovered on 2021 June 12.537 UT as an $8\overset{m}{.}4$ star by Ueda et al (2021). The star's light curve is shown in Fig. 1.

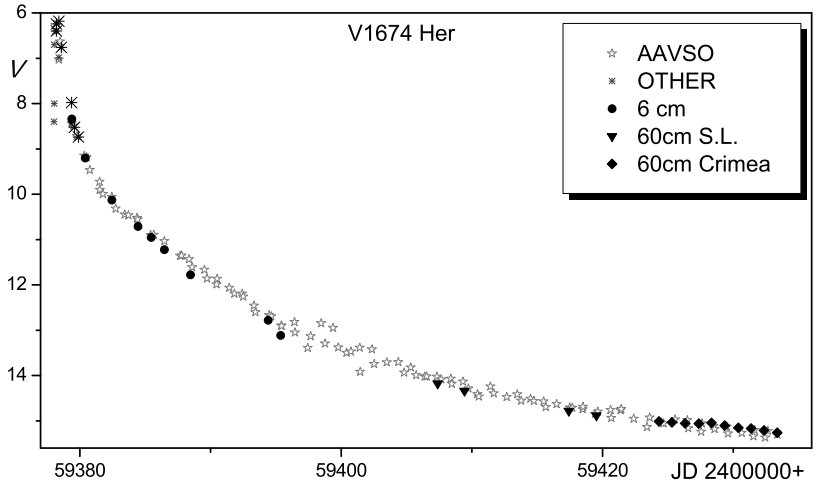

Figure 1. V-band light curve. Night-average magnitudes are shown except for the first three nights, where the data were averaged over intervals of 0.33 days. Our observations as well as data from various sources are shown.

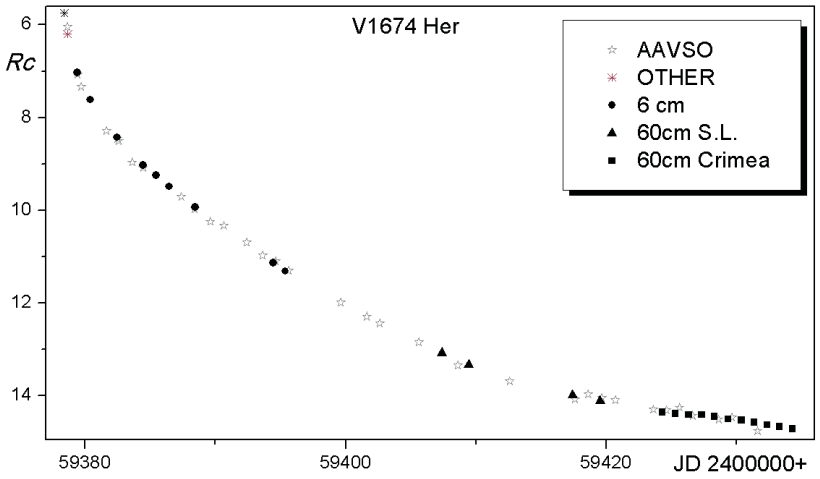

Figure 2. R_c-band light curve. See the caption to Fig. 1.

The spectrum is generally blue and shows broad absorptions (FWHM about 3000 km/s) compatible with P-Cyg profiles of Balmer, He I, Fe II, and other lines. The reddening was determined as $E_{(B-V)} = 0\overset{\text{m}}{.}55$ (Munari et al., 2021; Aydi et al., 2021; Kuin et al., 2021; Wang et al., 2021) Using the Fermi-LAT data for 0.1-300 GeV taken on 2021/6/12, an uncatalogued gamma-ray source was found at the Nova's position (Li, 2021; Sokolovsky et al., 2021)

According to Mroz et al. (2021), our object had a short period of $0\overset{\text{d}}{.}00580356$ (8.357 min), which is presumably a spin period of the white dwarf, and the system is an intermediate polar. The lines of [Ne III], [Ne IV] were also found in the spectrum. The presence of these strong neon emission lines is likely attributable to overabundances of neon, showing that V1674 Her is a member of the class of neon Novae, such as QU Vul, V838 Her, V1974 Cyg, etc. (Wagner et al., 2021; Ochner et al., 2021). The observation on July 1 showed that the super-soft source phase of V1674 Her had begun (Page et al., 2021). According to Patrick Schmeer (see Ueda et al., 2021), the likely progenitor is a $\sim 20^m$ star.

2 Observations

After the announcement of the Nova's discovery, we commenced multicolor photometry of the object. From June 13 to June 29, BVR_cI_c observations were carried out using a 60/180 mm photographic lens and SBIG-ST10XME CCD camera. Between July 11 and 23, a 600/7500 mm telescope and FLI ML3041 CCD camera in $UBVR_cI_c$ photometric bands were used. Observation were performed at the Astronomical Institute of the Slovak Academy of Sciences in Stara Lesna. From July 28 to August 7, $UBVR_cI_c$ monitoring was carried out at the Crimean Laboratory of the Sternberg Astronomical Institute using a 600/7500 mm telescope and FLI-39000 CCD camera. Seven stars around the variable were used as reference stars. The magnitudes of these stars were determined by referencing them to the secondary photometric standard around YY Her (Henden & Munari, 2021),

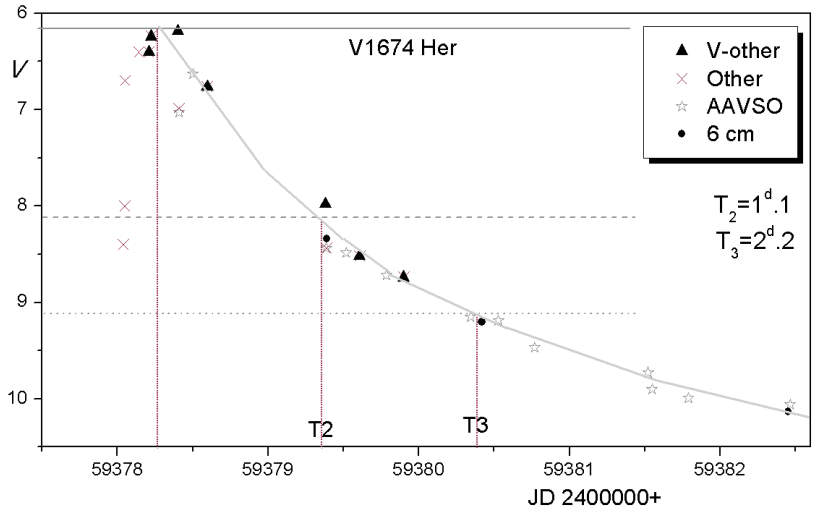

Figure 3. V-band light curve for the first four days after the outburst. The horizontal lines correspond to fading by 2 and 3 magnitudes from the maximum brightness. Black symbols show more accurate data.

and also corrected using data taken from the AAVSO catalog for standard stars around the same variable. As a result, a star with coordinates RA = $18^{\rm h}58^{\rm m}56\overset{\rm s}{.}8$, Dec = $+16°51'07''$ (J2000), its magnitudes being $B = 11\overset{\rm m}{.}07$, $V = 9\overset{\rm m}{.}90$, $R_c = 9\overset{\rm m}{.}18$, $I_c = 8\overset{\rm m}{.}58$ was used as the main standard star for frames taken with the 6 cm photographic lens. For the 60-cm telescopes, a star with coordinates RA=$18^{\rm h}57^{\rm m}41\overset{\rm s}{.}5$, Dec = $+16°57'29''$ (J2000) having $U = 12\overset{\rm m}{.}89$, $B = 12\overset{\rm m}{.}83$, $V = 12\overset{\rm m}{.}24$, $R_c = 11\overset{\rm m}{.}72$, $I_c = 11\overset{\rm m}{.}44$ was the main standard star.

3 Description and Preliminary Analysis of the Light Curves

The light curves for our time interval are shown in Fig. 1 (V band) and in Fig. 2 (R_c band). To these figures, we also added observations from the AAVSO and observations by other authors published in various sources. A rapid fading from $6^{\rm m}$ to $\sim 15^{\rm m}$ is seen. The total outburst amplitude is about $14^{\rm m}$. Note that the largest outburst amplitude among classical Novae was detected for V1500 Cyg and amounted to $19^{\rm m}$ (Honda et al., 1975; Harevich et al., 1975; Young et al., 1976).

Figure 3 shows the light curve for the first 4 days after the outburst on a large scale. This graph permits us to estimate the time of brightness decline by 2^m and by 3^m after the light maximum. According to our estimates, they are $T_2 = 1\overset{\rm d}{.}1$, $T_3 = 2\overset{\rm d}{.}2$. The fastest classical Novae known so far are V838 Her, V4160 Sgr and V1500 Cyg; for them, $T_2 = 1^{\rm d}$, $2^{\rm d}$, and $2^{\rm d}$; $T_3 = 4^{\rm d}$, $3^{\rm d}$, and $4^{\rm d}$ respectively (Strope et al., 2010; Young et al., 1976). Thus, V1674 Her is the fastest known Nova star (Wagner et al., 2021).

We carried out multicolor monitoring of the object during days 39–56 (JD 2459417–434) after the outburst maximum. Optical BVR_cI_c modulation with a period of $0\overset{\rm d}{.}15290(3)$ was found. The profile of the light curve has an amplitude close to $0\overset{\rm m}{.}12$ and shows two unequal minima separated by half a period. We assume that this period can correspond to orbital motion in the close binary system V1674 Her. The light curve folded with the ephemeris $\mathrm{JD}_{\mathrm{hel\ min}} = 2459426.327 + 0\overset{\rm d}{.}15290 \cdot E$ is presented in Fig. 4 and Fig. 5 (see also Shugarov and Afonina, 2021).

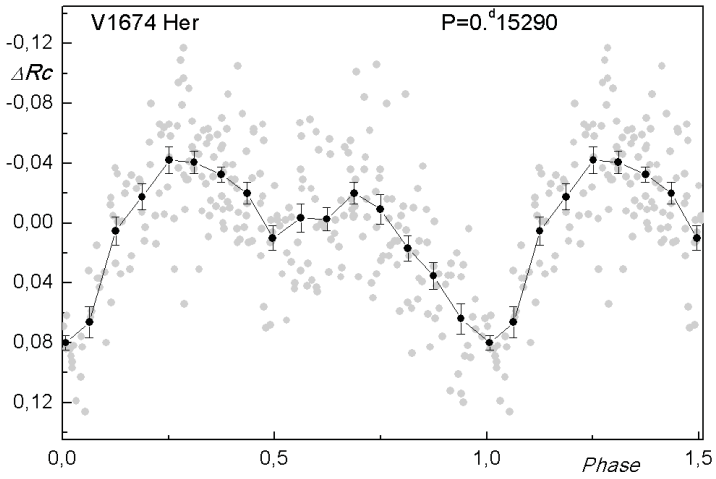

Figure 4. Light curve folded with the period we found in the R_c band for the JD 2459417–434 interval.

4 Conclusions

V1674 Her is a very important object for future studies. According to our data, the object has the steepest brightness-decline gradient among all known Classical Novae ($T_2 = 1\overset{d}{.}1$; $T_3 = 2\overset{d}{.}2$). Likely, it is an intermediate polar with a white-dwarf rotation period of $0\overset{d}{.}058$, orbital period $\sim 0\overset{d}{.}153$. Also, it is a member of the neon Novae class, has a large outburst amplitude, reaching 14^m; it is a gamma-ray source and an SSS source. Therefore, further comprehensive observations of this star are very relevant.

Acknowledgments
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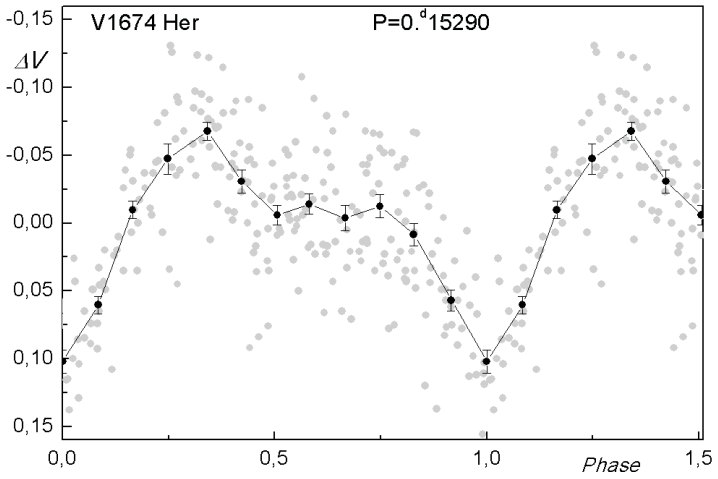

Figure 5. Light curve folded with the period we found in the V band for the JD 2459417–434 interval.

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