On the eclipsing cataclysmic variable star HBHA 4705-03

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ABSTRACT

We present observations and analysis of a new eclipsing binary HBHA 4705-03. Using decomposition of the light curve into accretion disk and hot spot components, we estimated photometrically the mass ratio of the studied system to be \( q = 0.62 \pm 0.07 \). Other fundamental parameters was found with modeling. This approach gave: white dwarf mass \( M_1 = (0.8 \pm 0.2) \, M_\odot \), secondary mass \( M_2 = (0.497 \pm 0.05) \, M_\odot \), orbital radius \( a = 1.418 \, R_\odot \), orbital inclination \( i = (81.58 \pm 0.5)^\circ \), accretion disk radius \( r_d/a = 0.366 \pm 0.002 \), and accretion rate \( \dot{M} = (2.5 \pm 2) \times 10^{18} \, [g/s], \, (3 \times 10^{-8} \, [M_\odot/yr]) \). Power spectrum analysis revealed ambiguous low-period Quasi Periodic Oscillations centered at the frequencies \( f_1 = 0.00076 \, Hz \), \( f_2 = 0.00048 \, Hz \) and \( f_3 = 0.00036 \, Hz \). The \( B - V = 0.04 \) [mag] color corresponds to a dwarf novae during an outburst. The examined light curves suggest that HBHA 4705-03 is a nova-like variable star.

Key words: accretion, accretion discs - binaries: cataclysmic variables, stars: dwarf novae, oscillations, stars: individual: , HBHA 4705-03, 1RXS J221653.0+464804

1. Introduction

Following Internet web sides of amateur astronomers we noticed a report by Korotkii and Krachko (2006) on a new interesting variable. They found it is an eclipsing binary. We decided to conduct observations of HBHA 4705-03 in order to study this interesting object closer. Light curve of this star suggests it is a member of cataclysmic variable stars group. Non-magnetic cataclysmic variable stars are short-period binaries where a white dwarf primary is the accretor of matter from a late-type Roche lobe filling secondary star via an accretion disk. The matter from the secondary moves into the stream and collides with the matter stored in the
vicinity of the accretion disk. A hot spot is formed in the region where the stream strikes.

Cataclysmic variables (CVs) made a rather extensive class of objects characterized by a vast diversity of behaviours of their light curves (Warner 1995). There are eruptive and non-eruptive members of CVs. These non-eruptive stars are called nova-likes. First observations of HBHA 4705-03 suggest that it belongs to an unknown class of CVs. This previously unexplored object raised our curiosity, so we decided to investigate it.

Most recently we have found than Yakin et al. (2013) presented their work dedicated to this object. They used photometric and spectroscopic observations, while we used only photometry. They obtained qualitatively similar, however slightly different, result to ours. Since the data analysis in our study was based on a different method than Yakin et al. (2013), we decided to present our results.

2. Observations and reduction

Observations of HBHA 4705-03 were made on August 26 (2010). We used Russian-Turkish 1.5-m telescope (hereafter RTT150) located at the TUBITAK National Observatory (TUG). SDSS g′ filter (λ0 = 475nm) was used during observations. This telescope can work for the photometry and the spectroscopy in two distinct modes. Namely, the coude mode and the cassegrain mode can be used (for detail see the official TUG webpage: [http://www.tug.tubitak.gov.tr]). We made observations in the Cassegrain mode using ultra-fast the ANDOR iXon DU-888 CCD camera. The iXon DU-888 camera is equipped with back-illuminated 1024x1024 pixels CCD. The instrument is mounted in Cassegrain focus f = 1/7.7 and gives ∼ 4 × 4 arcmin field of view. This camera works in EMCCD (electron multiplying CCD) mode, which reduce significantly readout noise effect at very short exposure times. The CCD is cooled thermoelectrically to a temperature of −60°C. The entire CCD array can be readout up to 8 times per second. When reducing the readout region and binning rows, the exposure time can be reduced to ∼ 1 ms.

We used the following procedure for the data collection (compare with Revnivtsev et al. 2012). At first, a small sub-frame (1024x60 pixels) of the full CCD was chosen. The variable star and a comparison star was inside this sub-frame. After an exposure, this sub-frame is automatically binned to obtain a "one dimensional strip" of 1024x1 pixels. In this form the exposure is saved to a hard disk. Above procedure allows to obtain exposures with the integration time of 0.0317 sec. The photometric measurements were made in a one-dimensional strip with a fixed center. The aperture width was determined from the summed one-dimensional brightness profile on the CCD. During nearly 7 hours of our observational run we collected 769986 measurements of the variable star and its comparison object. Because of the large number of frames collected, the data was stored in a 3-D "data cube" FITS file. In order to extract measurements from this 3-D format, we cre-
ated a CCD Data Reduction routine working under the IDL\textsuperscript{1}. Intrinsic intensities of HBHA 4705-03 were obtained by dividing the variable star fluxes over the comparison star. Comparison star (hereafter Comp A) is located at $\alpha = 22:16:47.42$, $\delta = +46:47:30.3$. To obtain the apparent magnitude $g'$, we assumed a linear change in spectral flux distribution between $B$ and $V$ passbands. Then the $g'$ of Comp A was interpolated. $B$ and $V$ magnitudes were taken from the Naval Observatory Merged Astrometric Dataset (NOMAD1) (Zacharias et al. 2005) which is linked with the SIMBAD astronomical database. This approach allows us to estimate the magnitude $g' = 14.8 \pm 0.5$ of the Comp A.

In order to better understand the studied object we observed it on June 11, and June 12, 2012 with the 1-m TUG telescope. Each observing run lasted $\sim 4.5$ hours. Observations were made mostly in the $V$ filter but time to time we also used $B$ and $I$ filters. This telescope has been designed for Ritchey-Chrétien optical system and is equipped with the SI (Spectral Instrument) 1100 Series CCD camera. The whole CCD chip includes 4096x4037 pixels and is cooled by closed cycle refrigeration unit down to -100 C (http://www.tug.tubitak.gov.tr/t100_si_ccd.php).

During two nights of observations we collected 817 frames, with the average exposure time 20 sec. We used the standard data reduction and aperture photometry to analyse these data. The object located at $\alpha = 22:16:54$, $\delta = +46:46:04$ was used as a comparison star (Comp B).

Figure 1. presents an exemplary reduced frame where the variable and the comparison stars are marked.

3. Light curve

3.1. Data from August 26, 2010 obtained with RTT150

We collected 769986 frames in the "$g$" filter. The raw photometric data do not reveal brightness modulation because of a high noise level. Due to the large number of points we binned them with 20 second bands to increase the S/N ratio. The obtained light curve can be found in Figure 2. Average errors for these observational points are close to 0.04 mag.

We detected two prominent minima with the amplitude $\sim 2.5$ mag. Before each of the eclipses a prominent hump can be observed. This is a well known profile for eclipsing cataclysmic variable stars. The mentioned humps are obviously the manifestation of the hot spot located on the disk - stream intersection. The orbital revolution causes reorientation of the hot spot and in consequence variations the in the observed light curve. In addition, we can notice a prominent, intriguing tooth-shape modulation in the middle between consecutive minima. We do not have a

\textsuperscript{1}The Interactive Data Language (IDL) is a proprietary software system distributed by Exelis Visual Information Solutions, Inc. (http://www.exelisvis.com)
Figure 1: Finding chart of HBHA 4705-03. The variable is marked by the V. The comparison star (A) was used for the RTT150 telescope data, while the comparison star (B) was used for the data gathered in 2012 with 1-m telescope. The chart gives roughly 5.5’x5.5’ field of view.

Figure 2: Light curve of HBHA 4705-03 in the $g'$ filter obtained with the RTT150 on August 26, 2010
simple interpretation for this behaviour and we will return to this phenomenon in Section 4.

3.2. Data from June 11 and 12, 2012 obtained with 1-m telescope

Figure 3 presents the light curve obtained on June 11 and 12 in 2012. During this run we used only the $V$ filter to obtain the light curve, while $B$ and $I$ measurements were made only one time in order to check the color characteristic. The $B$ and $V$ magnitudes of the comparison star B were taken from the NOMAD1 catalog, while the $I$ magnitude was taken from the USNO-B1 catalog. After calibration we estimated magnitudes of HBHA 4705-03 to be 15.25 in $B$, 15.21 in $V$ and 14.03 in $I$ (the measurements were obtained close to date HJD=2456090.5661). The obtained light curve presents a very good quality and in general the errors are around 0.005 mag. Again, there are visible obvious eclipses caused by transits of the secondary which covers the accretion disk and the hot spot.

However, the tooth-shape modulation occurring between eclipses in the RTT150 data from 2010 are not visible in the data obtained with 1-m telescope in 2012.

Either this modulation is not present in the system during the 2012 run of observations or they are simply not visible in the $V$ band. A temporal appearance and disappearance of these tooth-shape variations would not be unusual. Many other variable stars belonging to the sub-class of novae or nova-like objects change their
curves in the similar way to HBHA. Our experience tells us that the light curve variations can affect both its shape and the brightness.

3.3. Orbital period of the system

One of the most important physical parameter which defines many others in cataclysmic variable star is the orbital period. In the case of HBHA 4705-03, we have only 4 determined eclipses over two years. This is simply not enough for the standard Fourier analysis. Instead, we determined times of the minima by fitting a polynomial function to each of the eclipses. Then we found periods between detected minima in each year of observations. After calculation of the average of the results from 2010 and 2012, we found that the period equals to 0.171867(59) days. We interpret this value as the orbital period of the system.

4. Frequency analysis of the RTT150 data

High time resolution of the RTT150 data gives us opportunity to conduct the frequency analysis. As a tool we used the ZUZA code written by Schwarzenberg-Czerny (1992). The orbital humps after maxima and eclipses were excluded from the analysis. We examined two ranges of the light curve, i.e. between 0.27 – 0.33 d and 0.41 – 0.51 d (see Fig 2). The obtained power spectrum is shown in Figure 4. We used the perort routine of ZUZA to obtain the AOV (Analysis of Variance - Schwarzenberg-Czerny 1989) periodogram with two harmonics. The periodogram for the data collected before the first maximum (the upper panel on Fig.4) shows a prominent peak centered at the frequency \( f_1 = 0.00076(7) \) Hz (solid curve). Doubled prewhitening procedure allowed us to remove low-frequency variations from the light curve. Resulting periodograms shown by dashed and dotted lines in the Fig. 4 present no other significant frequency. The power spectrum of the second range of data is presented on bottom panel of Fig 4. Here the situation is different. Much more complex structure of the peaks can be noticed. Neglecting low-frequency signal in the spectrum which is resulting from the imperfectly removed trend, we can measure two peaks at the frequencies \( f_2 = 0.00048(3) \) Hz and \( f_3 = 0.00036(3) \) Hz. After prewhitening and removing low-level frequency peak centered at the frequency \( 8 \times 10^{-5} \) Hz with its three harmonics we got the spectrum presented by the dashed line. Thus, we revealed an additional frequency close to \( f_1 \) which is also present in the data before the first minimum. It suggests that Quasi-Periodic Oscillation (QPO) around \( f_1 \) is persistent for the whole observational period – before and after the minimum. An ambiguous characteristic of detected variability (in particular for long periods) do not allow them to be classified as Dwarf Nova Oscillations (DNOs) neither to common QPOs. However, this type of variability – in analogy to the known characteristic of DNOs and QPOs in dwarf novae (Warner & Woudt 2005) – suggests a high mass transfer rate during the time of observations.
5. Analysis of the eclipses

5.1. Decomposition into spot light curve and disk light curve

Detected eclipses in the light curve gave us a chance to find fundamental physical parameters of HBHA 4705-03. The most fundamental parameter is the orbital period of the system which we estimated in Section 3.3. To derive other parameters, a more developed method must be used. After the intensive study of literature dedicated to the problem of analysis of eclipse light curves of CVs (see the review of Horn 1993) we decided to follow the approach by Smak (1994a,b). Introducing minor modifications into the original method we have decomposed the observed light curve on the hot spot light curve and the disk light curve. This analysis gives the best result for the shape of eclipse light curve which is described by the standard model of a cataclysmic binary with stationary accretion. For short, this model predicts approximately constant brightness of the system during roughly one-half of the cycle and orbital hump, which occurs in the phase interval from about $\phi = -0.4$ to about $\phi = 0.1$. Particularly important from the point of view of the assumed methodology is the fact that the declining part of the orbital hump is still clearly visible after the eclipse.

Analysis of the light curve from 2010 did not give satisfactory results. Evidently the shape of the eclipse which is far from the "standard" case made it impos-
sible to obtain the reliable result. Thus, we decided to obtain an additional observations of the studied object. We used the data gathered from the 2012 campaign to produce phased eclipse with minimized flickering. Results of this approach are presented in the Fig. 5. One can notice a clear shape of the hot spot light curve. Four phases of contact ($\phi_1, \phi_2, \phi_3, \phi_4$) can be determined with relatively good accuracy which is estimated as $\pm 0.003$ in phase units. Those phases are marked by vertical lines in the Fig. 5. Although, the presence of the flickering is still visible in the light curve, the shape of the uneclipsed part of hot spot light curve agrees quite well with the theoretical formula presented in Paczyński & Schwarzenberg-Czerny (1980, Eq. 4)

$$I(\phi) = I_{s,\text{max}}[1 - u + u \cos(\phi - \phi_{\text{max}})] \cos(\phi - \phi_{\text{max}}).$$

(1)

Used symbols denote: $I_{s,\text{max}}$ - the hump amplitude, $u$ is the limb darkening coefficient (for which we adopt $u = 0.6$) and $\phi_{\text{max}}$ is the phase of hump maximum. Table 1. presents the fitting parameters of this function:

| $I_{s,\text{max}}$ | $\phi_{\text{max}}$ | $\phi_1$ | $\phi_2$ | $\phi_3$ | $\phi_4$
|-------------------|-------------------|--------|--------|--------|--------|
| 0.382             | -0.052            | -0.078 | -0.035 | 0.093  | 0.107 |

Reconstructed disk light curve is also well defined. However, its shape is not clearly symmetric. Most likely two effects play a role here: flickering and the complex structure of the disc, especially non uniform distribution of the surface brightness. We should also take into account that it may not be the case of stationary accretion. Even so, we do not have much more other ways to estimate the mass ratio of the system. Despite the danger of contradiction between the possible non-uniformity of the disk and the assumption of the stationary accretion we hope at least for crude estimation of the $M_1$ and $q$.

5.2. Model analysis and assumptions

One of the most serious issues regarding light curve model analysis is the problem of appropriate assumptions. One have to find the way to collect as many starting parameters as possible. In Sec. 3.3, we derived the first one – orbital period. The second parameter which affects the other parameters is the stellar components mass ratio. Here we used the convention $q = M_2/M_1$, where $M_2$ is the mass of the donor and $M_1$ is the mass of the white dwarf. Following Smak’s approach (Smak
Figure 5: Decomposition of the HBHA 4705-03 light curve into spot and disk components. The observed light curve is shown by crosses. Dots indicate reconstructed spot light curve. The theoretical spot light curve outside the eclipse are presented by dashed line. The solid curves are the model light curves corresponding to the disk light solution (upper) and the spot light curve solution (bottom). Vertical lines indicate four moments of eclipse contacts.
we did not assume value of the mass ratio \( q \) but instead, we check a wide range of parameters in order to estimate it. Knowing masses and the orbital period we can derive the orbital semi-major axis \( a \) via the Kepler Law.

Cataclysmic stars obey the well known relation between the orbital period and the mass of the secondary, \( M_2 = f(P,M_1) \) Patterson (1984). This allowed us to estimate the mass of the secondary to be \( M_2/M_\odot = 0.4970 \). The temperature of the secondary was derived with the following formula taken from Popper (1980):

\[
\log T = 3.760 + 0.633 \log \frac{M_2}{M_\odot}
\] 

(2)

We assumed that the relative luminosity of the white dwarf (WD) is small and WD itself is obscured by internal regions of the accretion disk. Based also on the other works (e.g. Sion 1991) we adopted here the standard temperature of the white dwarf which is suitable for such a system, \( T_1 = 30000 \) K. At this point, we need to add that the final fit barely depends on the assumed temperature. The radius of the primary can be determined from the theoretical mass radius relation (e.g. Nauenberg 1972, Provencal et al. 1998) for white dwarfs. The surface brightness distribution of the component in a given passband is a function of temperature and limb darkening \( u \). Here we adopt the standard value of the linear limb darkening coefficient, \( u = 0.6 \), for WD and disk components. For the secondary we assumed that this coefficient is equal to 0.3. We also assume the standard temperature profile for a flat disk \( T_d \sim R^{-3/4} \).

Therefore, the starting point for the modeling was the following set of parameters: \( M_1, M_2, R_1, a, u_1, u_2, u_{\text{disk}}, T_1, T_2 \). We also assumed that the secondary fills its Roche lobe and the hot spot is located on the edge of the accretion disk. As a useful tool for modeling we used the LCURVE program written by Tom Marsh. Decomposition of the light curve allowed us to analyze the disk and the hot spot components separately. Starting from the modeling of the disk light curve we have tested different masses of the primary (from \( 0.4 M_\odot \) to \( 1.4 M_\odot \)). Here we modeled only the inclination of the system, the radius, and the temperature of the accretion disk. Based on the knowledge on vertical structure of the disk, we assumed the most probable value of the disk thickness. The average mass transfer rate for a nova-like variable was found to be \( \sim 9.3 \times 10^{-9} M_\odot \text{yr}^{-1} \) (e.g. Puebla et al. 2007, Ballouz et al. 2009). Using the analysis made by Smak (1992) we adopted \( z/R \approx 0.063 \) in our models. When testing this assumption, we noted that changing \( z/R \) in a rather wide limit (from 0.63 to 0.1) change the system inclination noticeably. On the other hand the disk radius is changed barely.

Similar modeling was conducted for the spot light curve. We assumed that the radius of the accretion disk is the same as the distance of the white dwarf to the hot spot, i.e. the hot spot is located on the accretion disk edge. Initial parameters for this step of analysis (like the temperature of the accretion disk and the system inclination) was taken from the disk light curve solution.

Both model analyses described above give a family of solutions for different
Figure 6: The mean $r_d/a = f(M_1)$ relation from disk light solutions is shown by solid lines. The upper and the bottom lines show $r_d/a$ determination errors. Dotted lines represent $r_s/a = f(M_1)$ relation for spot light solution ($r_d$ represent the outer radius of the disc and $r_s$ is the distance of the hot spot to the white dwarf). Oblique cross shows the final solution for $M_1$ and $r_d/a$. Its possible uncertainty is presented by the shady region.
assumed $M_1$. Figure 6 presents the relations of the accretion disk radius to semi-major axis ratio versus the primary mass obtained both from the disk light curve solution ($r_d/a = f(M_1)$) and the spot light curve solution ($r_s/a = f(M_1)$) presented by the solid and dotted lines, respectively. Placing both families of the solutions on one graph we obtained a shady region presenting possible values of $M_1$. The black cross indicates the center of the found zone and the most likely value of $M_1$ and $r_d$. Moreover, the obtained synthetic disk and spot light curves are presented in Figure 5. Turning our attention to disk light curve we can notice that the fit for is very good in the center, however, less perfect in the "wings". Systematically fainter model disk light curve suggests the higher temperature of the outer regions of the accretion disk. Not strictly smooth observed disk light curve suggests a non uniform structure of the disk which is very difficult to model. The resulting model of the spot light curve seems very good, though. This model differ very little from the theoretical relation given by Paczyński & Schwarzenberg-Czerny (1980).

6. Results

Disk/spot light curve solutions provide the following parameters for the system $M_1/M_\odot = 0.8 \pm 0.2$, $M_2/M_\odot = 0.497 \pm 0.05$, $a = 1.41821 R_\odot$, $r_d/a = 0.36 \pm 0.02$, $i^\circ = 81 \pm 0.1$. Those parameters were taken as initial parameters used later for the overall observational light curve modeling. LCURVE code allowed us then to model HBHA 4705-03 including four components: the white dwarf, the secondary star, the accretion disc and the hot spot created at the place where the stream hits the edge of the disk.

The mass ratio was fixed to be 0.62. The rest of the parameters (except those assumed in section 4.2) were obtained using model analysis. The best fit of the light curve solution in this approach is presented in Fig. 7. Generally, the synthesized light curve agree quite well with the observed light curve of the eclipse. Table 1 presents parameters of the best fit solution and Fig. 7 shows its graphical representation. Simplex minimization method was used at first to find the global minimum. Next, the Levenberg-Marquardt method (Levenberg 1944, Marquardt 1963, see also Bates 1988) was used to obtain the final solutions by the levmarq routine. Once the optimal curve-fit parameters were determined, their errors were deduced from the parameters the covariance matrix.

6.1. Comparison with Yakin et al.

Comparison of our results with those presented by Yakin et al. (2013) suggest that one should treat both results with caution. The main problem in the modeling of the light curves is the correct estimation of the mass ratio of the components and the inclination of their orbit plane. Theoretical relations allow to estimate $M_2$ with
Table 2

Resulting parameters of HBHA 4705-03

| Parameter | Value                       |
|-----------|-----------------------------|
| $M_1 / M_\odot$ | $0.8 \pm 0.2$               |
| $M_2 / M_\odot$ | $0.497 \pm 0.05$            |
| $a [R_\odot]$ | $1.41821$ (calculated)      |
| $i[^\circ]$    | $81.58 \pm 0.5$             |
| $t_1 [K]$      | $30000$ (assumed)           |
| $t_2 [K]$      | $3696$ (calculated)         |
| $r_d / a$      | $0.366 \pm 0.002$           |
| $\dot{M} [g/s]$ | $(2.5 \pm 2) \times 10^{18}, (3 \times 10^{-8} M_\odot/yr)$ |

Figure 7: Comparison between the observational data of HBHA 4705-03 and the best fit found with the LCURVE code (solid line)

statistical good accuracy. So, the main parameter to be determined is the white dwarf mass. We found $M_1 = 0.8 \pm 0.2 M_\odot$. The error of this measurement gives a wide possibility of the modification for the other parameters. For example, if we adopted $M_1 = 0.6 M_\odot$, then this value would agree with $M_1 = 0.54 \pm 0.1 M_\odot$ found by Yakin et al. The rest of the parameters would change accordingly to the mass ratio. One should also remember about the six-year time difference between the observations of Yakin et al. and ours. In particular, for that reason, the disk and
the hot spot parameters can be significantly different and can bias the rest of the parameters obtained from the model analysis.

7. Conclusions

Part of the below conclusions was already introduced in the abstract of this article. The observations of the new discovered variable star HBHA 4705-03 in the years 2010 and 2012 were presented. We were able to decompose the observed light curve into the hot spot and the accretion disk components. The eclipse of the hot spot is clearly visible. Model analysis of the both of light curve components separately allowed us to find intrinsic parameters for the disk and the spot. After combining these two solutions, we were able to find the mass ratio of the system and the accretion disk radius. At this point we had enough data to find the remaining global parameters. We detected uncommon variability with the period in the range from \( \sim 20 \) to \( \sim 50 \) minutes. Moreover, the LCURVE code allowed us to find the overall synthetic light curve of the system, including all major components i.e. the white dwarf, the red dwarf, the accretion disk and the hot spot.

7.1. Classification of HBHA 4705-03

The shape of the light curve and the found parameters like the orbital period, the accretion rate, the component masses and the \( B - V \) color, help us to made a classification of this object. Moreover, although there are no long-term light curves, eclipse light curve and spectra in this study combine with Yakin et al. (2013) may be very helpful to find the type of HBHA 4505-03.

As the orbital period of HBHA 4705-03 is very close to 4 hr, we focus on the CVs with period between 3 and 4 hr which are right at the upper edge of the period gap. In this period range, there are a lot of nova-like stars characterized by an approximately steady, high rate of mass transfer. In addition, nova-like stars with orbital periods between 2.8 and 4 hr are classified as SW Sex stars. These stars were first defined by Thorstensen et al. (1991). Observational features of SW Sex stars are summarized by Hoard et al (2003). They are high mass transfer rate nova-like stars. In the optical light curve of SW Sex stars, the white dwarf and the accretion disc are deeply eclipsed by the secondary star. This shows that their orbital inclination angles is higher than \( 80^\circ \). However, there are non-eclipsing SW Sex stars (Schmidtobreick et al. 2012), as well. They display high excitation spectral lines, including \( \text{He II} \ \lambda 4686 \) emission, which strength is often comparable to the strength of \( \text{H} \) lines. They show single-peaked emission lines in their spectra rather than double-peaked ones expected from a near-edge-on accretion disc. The Balmer and He I emissions are only shallowly eclipsed compared with the continuum emission. The zero crossings of their emission-line radial velocities present phase offsets relative to their eclipse ephemerides.

At first glance HBHA 4705-03 can be considered as a nova-like star since its
mass transfer rate is very high compared to dwarf nova. In addition, this system exhibits many features similar to SW Sex stars. White dwarf and accretion disc of the system is deeply eclipsed by the secondary star. This is evident as its inclination angle is found about 81° in our study. Optical spectra of HBHA 4705-03 are presented by Yakin et al 2013. In its optical spectra, He II λ emission line is prominent and its strength is comparable to H lines. Emission lines in its spectra are single-peak and the zero crossing of the radial velocity of He I λ4921 emission line shows a phase offset comparing to its eclipse ephemerides. These features demonstrate that HBHA 4705-03 can be a member of SW Sex class of the nova-like-type CVs.

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