PHOTOMETRIC OBSERVATIONS OF THE SYMBIOTIC STAR CH CYG IN 2018

Kh. M. Mikailov [a], ***R. T. Mammadov*** [b], ***N. I. Gulmaliyev*** [a*]

[a] *Shamakhy Astrophysical Observatory named after Nasireddin Tusi of the Azerbaijan National Academy of Sciences*

[b] *Batabat Astrophysical Observatory of Nakhchivan branch of ANAS*

Photometric observations of CH Cyg symbiotic star have been carried out at the Zeiss 600 telescope at the Shamakhy Astrophysical Observatory in the interval of 06.07.2018-16.09.2018 during 17 nights using the V-filter. The light curve for this star was set on the basis of our observations and AAVSO databases. Our results are completely in line with the AAVSO results. The star's light has increased during the observation period up to 2 stars size – from 8.5 to 6.5. Continuous observations have shown that short-term scintillations of the star occur during the night up to 0.2-0.45 magnitude. We suppose that the cause of these scintillations is the increase in the flow rate of matter from the red giant star to the surface of the white dwarf in the period close to the periastron.

Keywords: CH Cyg–Symbiotic star–flickering–CDD Photometry.

1. INTRODUCTION

Symbiotic stars are interacting binary systems surrounded by cover. They consist of advanced red giant and hot component – white dwarf. The material source of the cloud is red giant which loses its substance by star wind and pulsation, the energy source is the hot white dwarf.

CH Cyg (HD 182917) is the brightest and closest one among the symbiotic stars. The distance to this symbiotic star is about 244 parsec according to data of Hippacros [1]. Its visual star size increased up to $V = 5.5^m$ on 1982-1983 and decreased down to minimum of $V = 10.5^m$ in 1996. The brightness of the start in a still condition is mainly 7^m. Photometric observation of CH Cyg for more than 130 years is available, and it was studied comprehensively [2]. For long time CH Cyg was known as a single giant start pulsating in 100 days period in a little

* E-mail: mikailov.kh@gmail.com

amplitude. No any spectral changes, even in Morgan – Kinan's system it was accepted as M6III standard star. Only in 1963 after activation strong emission lines of blue continuum and hydrogen were seen. Since that time CH Cyg was accepted as a symbiotic star – binary of M7 cold giant and accreting white dwarf [6, 3]. Since the recognizing this star as a symbiotic star various lasting and various type of flickering have been observed, in 1967-1970, 1977-1983, 1992-1994, 1998-1999, 2011-2012 and 2017-2018.

CH Cyg is one of the rare symbiotics flashing in minute time scale [4]. Flickering disappears, blue continuum gets stronger and radiation lines are getting larger when jets are observed. Flickering reflect large spectral stochastic changes of brightness in several minutes time scale up to 0.01^m to 1m magnitude. Flickering activity has been observed only in 10 symbiotic stars: RS Oph, T GrB, MWC 560, V2116 Oph, CH Cyg, RT Cru, o Cet, V407 Cyg, V648 Car and EF Aql.

5-20 minutes of flickering has been observed in the spectrum of the symbiotic star of CH Cyg in the optical region profiles of emission lines and in the spectrophotometric parameters [5, 6].

Our aim is to provide information about results of high velocity photometrics symbiotic star of CH Cyg during july - september 2018 and flickering occurred in individual nights.

2. OBSERVATIONS AND RESULTS

Observations of CH Cyg star have been carried out in ZEISS-600 telescope of Shamakhy Astrophysics Observatory during 72 days between 06.07.2018 – 16-09-2018 and 17 nights. The telescope was fitted with CCD photo receiver of 4096×4096 pixel (1 pix= 9mic) size and with 17 arcmin of efficient visual area of photometer [7]. TYC 3551-1725-1 was chosen a comparison star, V2365 Cyg (SAO 31628) as a check star. For study of the character of faster changes continuous observations with high time resolution have been conducted during several nights and in only one filter (V).

Processing of the observation material has been conducted in MaxIm DL program following the standard procedures of aperture photometry. 3, sometimes 5 screenshots have been merged in order to increase the metric accuracy and cleaning of screenshots from the prints of space senses. Some comparison stars, as well as SAO 31628 binary start were used as a check star [8].

In the table 1 observation list is given. Observation date, number of screenshots and exposition period, lasting period of the observation, middle, maximum and minimum values of brightness and maximum changes have been given.

Observations have been conducted continuously within several nights. The most lasting observations have been conducted in 19-07-2018 – 148 minutes, 06-

08-2018 – 79 minutes and 16-09-2018 – 87 and 79 minutes. Continuity of observations in the other nights have been: 10 minutes in 10/11-07-2018 and 22-08-2018, 13-14 minutes in 18-07-2018 and 15-09-2018, 20 minutes in 07-08-2018, 37 and 42 minutes in 16-08-2018.

Light curve in V filter has been given in the figure-1 based on our observations and AAVSO database. As it is reflected in the figure, our results accord with the AAVSO results. CH Cyg star was active during observation period and increased its brightness from 7.56^m to 6.47^m.

Flickering. Photometric flickering of CH Cyg was identified by Wallerstein and Cester for the first time [9,10] and then have been comprehensively studied by various authors [11,12,13,14]. Flickering was not observed in 2010-2013, was observed again starting from 2014 [14].

Our observations also coincided to flickering time of the star. Nigh observations showed that several minutes lasting little amplitude of flickering occurs in the symbiotic star of CH Cyg. Light curves of several nights reflecting flickering in V filter of CH Cyg star are given in the figure 2. As it is reflected in the figure 2, character and amplitude of flickering was different from night to night.

Maximum change of brightness was 0.16^m for 7 minutes in 10-07-2018, 0.12^m for 5 minutes in 11-07-2018, 0.22^m for 10 minutes in 18-07-2018, 0.3m for 35 minutes in 19-07-2018, 0.3^m for 39 minutes in 06-08-2018, 0.21^m for 17 minutes in 16-08-2018, in the first half of observation, 0.27^m for 39 minutes in the second half of observation, the amplitude of flickering during the night was 0.36^m. It was 0.14^m for 03 minutes in 22-08-2018, 0.14^m for 24 minutes in the first half of observation in $06-09-2018^m$, 0.16^m for 26 minutes in the second half of the observation, amplitude of flickering was 0.45^m during the night. 0.22^m for 3 minutes in the first half of observation in 15-09-2018, 0.26^m for 8 minutes in the second half of observation, 0.14^m for 17 minutes in 16-09-2018 for the first half and maximum amplitude of flickering was 0.25^m.

Thus, changes in V brightness of CH Cyg symbiotic star with $0.1^m - 0.45^m$ amplitude in 1-30 minutes interval and $0.05^m - 0.06^m$ amplitude of changes happened in 10-30 seconds interval.

Periodicity. It is difficult to investigate the periodicity of flickering in CH Cyg symbiotic star because our observations didn't cover the extended period of time except some nights. But as it is clear from the figure 2 some periodic changes occur in some nights. For exploring the periodicity within a minute time scale we applied spectral furje analysis by using Scargle method in results of all our observations. As example power spectrum are introduced for value of V in 06-08-2018, 16-08-2018 and 07-09-2018 in the figure 3.

In the figure 4 phase diagrams of brightness in V filter for the dates of 06-08-2018, 16-08-2018 and 07-09-2018 are given. Short time changes in brightness of

CH Cyg star in V filter in dates of 06-08-2018 (79 minutes of observation) and 16-08-2018 (200 minutes) demonstrated close periodic values – 67 minutes and 65 minutes. Period of flickering was 12 minutes in 07-09-2018.

3. DISCUSSION.

Red Giants are stars which gained the required temperature for synthesis of helium in their nucleus. White Dwarfs are the stars approaching their end of life time and highly compressed ones. Those stars are so dense that they are nearly in the Sun's weight however their size equals nearly to Earth size. Because being 200000 times heavier than Earth, they have very strong gravitation. For that reason, they can gather bulk amount of substance of cold giant and in the most symbiotic systems white disc is generated around the white dwarf [15]. This happens due to rotation of binary system. As a result of rotation of binary system, the substance which is flowing out of the red giant bends down to white dwarf due to high gravitation of it. Rotation of the binary causes rotation of the white substance as well and it creates white disc around it. White dwarfs have such a powerful gravitation field that they can pull the substance of the other star of symbiotic system to itself. Mechanism of that process is called Roche Lobe Overflow. It means that, a star enlarges up to such grade that its ability of owning the outer layer decreases and the size of star increases beyond the Roche limit. When this happens, the excessive substance flows onto the binary and a disc emerges. Sometimes this accretion leads to generation of ionized gas cloud around the hot component.

Source of flickering in optical region in symbiotic stars are known to be a disc [16]. Researchers consider that flickering disappears when accretion disc destroyed [12] or magnetic propeller gets activated [11]. Faster changes were observed during flickering of stars. Changes in fluxes in U filter were 10-30% within several minutes. CH Cyg is unique changing star and demonstrates complex alterations of different character in the brightness graph and large diapason of spectrum. Observed long lasting alterations (variating in 10 years) are caused by orbital movements or increasement of the dust cover. Several alterations of 100 days are related to pulsation of the giant. Short term flickering activity relates to accretion disc. Increasement of activity of flickering since 2014 can be related to acceleration of processes in the disc as a result of increasement in amount of substance absorbed from the red giant while white dwarf moves through periastron in CH Cyg symbiotic system.

4. CONCLUSION.

Following results have been obtained from analysis of the observation of CH Cyg symbiotic star during 17 nights in the interval of 06-07-2018 – 16-09-2018 (72 days): 1. During the period of observation, the star increased its brightness in about 2 stars size and raised up to 8.5 – 6.5.

2. Continuous nigh observations showed that short term flickering of 0.2-0.45 size occurs in the star. It is estimated that the cause of flickering is increasement of the amount of substance flowing onto white dwarf from the red giant in the period when the white dwarf is close to periastron.

3. 67, 65 and 12 minutes of periodic alterations have been identified for flickering in various nights.

REFERENCES

1. Van Leeuwen, F., Hipparcos, the New Reduction of the Raw Data, Astrophysics and Space Science Library, 2007, Volume 350.
2. Mikolajewski, M., Mikolajewska, J., Khudiakova, T. N., A long-period symbiotic binary CH Cygni. I - A hundred years' history of variability, Astronomy and Astrophysics , 1990, vol. 235, no. 1-2, p. 219-23.
3. Deutsch, A.J., The spectrum of CH Cyg in 1963 // Ann. Rep. Mt. Wilson and Palomar Obs.1963-1964, 1964, p.11-15.
4. Dobrzycka, D., Kenyon, S. J., Milone, A. E., Rapid Light Variations in Symbiotic Binary Stars, Astronomical Journal, 1996, v.111, p.414.
5. Mikayilov, Kh. M.; Rustamov, B. N.; Alakbarov, I. A., Rapid Spectral Variability of the Symbiotic Star CH Cyg During One Night, ASPC, 2017, v.510, pp 170-173.
6. https://www.ta3.sk/conferences/75AI2018/talks/B12.pdf
7. Abdullayev, B.I., Alekberov, I.A., Gulmaliyev, N.I,.et al., A new photometer – polarımeter coupled wıth ccd, Azerbaijani Astronomical Journal, 2012, №4, p.39-47.
8. Henden, A.; Munari, U.UBV(RI)C photometric sequences for symbiotic stars, Astronomy and Astrophysics, October IV 2006, Volume 458, Issue 1, pp.339-340
9. Wallerstein, G., Photoelectric observations of rapid variations of CH Cygni, The Observatory, 1968, v. 88, pp. 111-112.
10. Cester, B., CH Cygni, Information Bulletin on Variable Stars, 1968, 291, 1
11. Mikolajewski, M., Mikolajewska, J., Tomov, et al., Symbiotic binaries. III - Flickering variability of CH Cygni: Magnetic rotator model, Acta Astron., 1990, 40, 129.

12. Sokoloski, J. L. and Kenyon, S. J., CH Cygni. II. Optical Flickering from an Unstable Disk, The Astrophysical Journal, 2003, v.584, pp.1027–1034.

13. Dingus, Thomas Holden, "Flickering Analysis of CH Cygni Using Kepler Data" (2016). https://dc.etsu.edu/cgi/viewcontent.cgi?article=1380&context=honors

14. Stoyanov, K. A.; Martí, J.; Zamanov, R., et al., Optical flickering of the symbiotic star CH Cyg, Bulgarian Astronomical Journal, 2018, Vol. 28, p. 42.

15. Sokoloski, J. L., Symbiotic Stars as Laboratories for the Study of Accretion and Jets: A Call for Optical Monitoring, Journal of the American Association of Variable Star Observers (JAAVSO), 2003, v. 31, pp. 89–102.

16. Sokoloski, J. L.; Kenyon, S. J., CH Cygni. I. Observational Evidence for a Disk-Jet Connection, The Astrophysical Journal, 2003, Volume 584, Issue 2, pp. 1021-1026.