Stars: from Collapse to Collapse
ASP Conference Series, Vol. 510
Yu. Yu. Balega, D. O. Kudryavtsev, I. I. Romanyuk, and I. A. Yakunin, eds.

Outburst of the Unusual Binary CSS160603: 162117+441254

N. Katysheva,[1] S. Shugarov,[1,2] and P. Golysheva[1]

[1]*Sternberg Astronomical Institute, Moscow State University, Moscow, Russia;* `natkat2006@mail.ru,polina-golysheva@yandex.ru`

[2] *Astronomical Institute of Slovak Academy of Sciences, Tatranskà Lomnica, Slovakia;* `s.shugarov@gmail.ru`

Abstract. Outburst of the star CSS160603: 162117+441254 in June 2016 attracted an attention of astronomers. Two years before outburst the star was classified as the contact system of the W UMa-type having a period of $P_{orb} = 0.^{d}2079$. Outburst was lasting for several days, then light curve and brightness of J1621 returned to the initial form.

1. Introduction

1.1. W UMa Stars

Numerous contact binary stars belong to the W UMa-class of close binaries. Their light curves (LCs) are characterized by symmetric forms with equal primary and secondary minima, as a rule. These systems consist of two late stars filling their Roche lobes with the periods (in average) $0.^{d}22$–1^{d} and have two subclasses – A (with A–F components) and W (with later stars). Many authors investigated these systems and determined their physical parameters. Some times the stellar spots can change the LCs. Practically all these stars change the orbital periods (see review by Dryomova and Svechnikov, 2006).

As it was noted in the monograph "Close binary stars" by A.M. Cherepashchuk (2013), last years many new contact systems have been discovered, their parameters were calculated and evolution status was studied. Evolution relationship between the W UMa-binaries and RS CVn-stars with strong chromospheric activity was described. And one of such possibilities is a transition from RS CVn-type binaries to contact systems.

1.2. A New W UMa Star?

A new star 2MASS J16211735+4412541 = CSS160603: 162117+441254 (further J1621) was identified as a contact eclipsing system of the W UMa-type with $P_{orb} = 0.^{d}207852$ by Palaversa et al. (2013), Lohr et al. (2013), Drake et al. (2014a, b). This period is a bit smaller of minimal period $0.^{d}22$ of the W UMa-binaries.

An outburst was detected by Drake et al. (2016) in June 3, 2016. The authors suggested that a white dwarf and the main sequence star (WD+MS) system was more preferable the MS+MS system, so, it could be unusual cataclysmic variable. Maehara

(2016) reported about pre-discovery observation of this star. It was already in outburst at V=13.3 in June 1, 2016.

Scaringi et al. (2016) received a first spectrum and found H alpha, H beta, HeII 4686 emissions that was very similar dwarf nova spectra during the outburst. Thorstensen (2016) valued a compact object as the white dwarf with 0.9 M_{sun}. Zeida and Pejcha (2016) observed outburst and returning to contact stage, Zola et al. (2016) observed a contact phase. Pavlenko et al. (2016) provided the observations in June 5, 7–9 and found additional period $0.^{d}052106$, which, possibly, was explained to associate with rotation of magnetic WD.

The both plots of light curves (and Zeida and Pejcha, and Pavlenko et al.) are very similar – the first LC (June 5) has a deep primary minimum (with $\Delta m \sim 1$) and very shallow the secondary one, which gradually deepens.

Our observations during the outburst were carried out on the telescopes of the Astronomical institute of Slovak academy of sciences (Stara Lesná). In July we continued to observe at the Crimean observatory of Moscow State University. The star TYC3068-00855-1 with R_c ~11.9 was used as a standard. We also took the data from the AAVSO database to study the behaviour of J1621 during the outburst (AAVSO, 2016). Note, that amateurs make a large contribution to the treasury of astronomical data, especially, cataclysmic variables. Otero (AAVSO, 2016) discovered the another outburst in August 4, 2006 and evaluated its magnitude as 13.1 during outburst of 2006 and in June 2, 2016.

Our phase light curves from June 5 till June 16 (from top to bottom) are present in Figure 1 (left). July and middle of June LCs are shown in Figure 1 (right). The low LC of Figure 1 (left) is an aggregated LC (June 10, 12, 14). The LCs by Zaida–Pejcha (2016) and Pavlenko et al. (2016) are more complete than ours, it is connected with not good weather during our observations.

On Figure 2 the decline of outburst LC from AAVSO data (left) and phase light curve of June, 3 are shown. The phase curves were obtained using the ephemeris $HJD(min1) = 2457574.4411 + 0.^{d}207852 \cdot E$.

It is seen clearly that the outburst LCs changed every day: upper LC (June, 3) (see Figure 2, right) is very similar to dwarf nova LC, with eclipse depth more 1 mag and only a slight hint on secondary minimum. Every other day secondary one becomes deeper, but the primary one – shallower. From Figure 1 (right) we can see that the secondary minimum became deeper than the primary one when the system returned to quiescence.

If maximum of brightness was on the the 1st or 3rd of June, then a duration of outburst is small – of about 9–7 days.

AAVSO data was obtained without filter ("Clear filter"), in general, and in BV-bands. And in some nights only "Clear" and B or V observations were provided. So, it is difficult to have "colour-indice" $B - V$, $V - R_c$ for all decline. Only at JD 2457549 it was possible to value $< B - V > = 0.742$.

Simultaneous multicolor BVR_cI_c observations were made at the telescope AZT-11 of Crimean astronomical observatory in June 7–11 (see paper by Pit′ et al., this volume). LCs and two-colour diagram, where the position of J1621 is shown, are present in their paper.

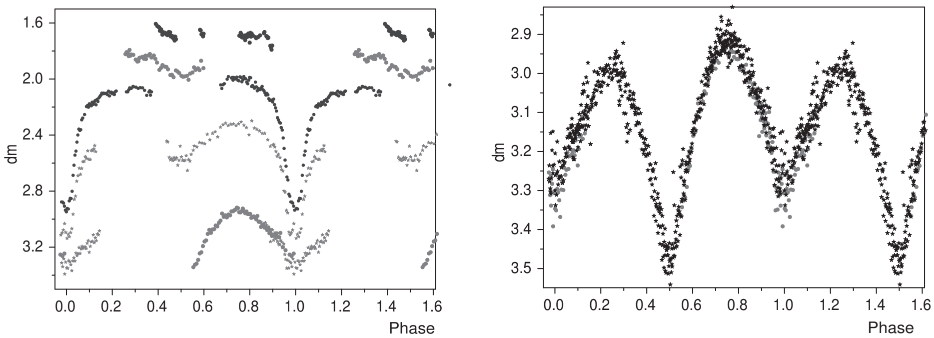

Figure 1. The phase *Rc*–LCs (in relative magnitudes). Data were folded with our ephemeris. *Left:* From top to bottom: June, 5–8, 12, 14, 16, 2016. *Right:* June12, 14 and 16 (points) and July 2016 (stars).

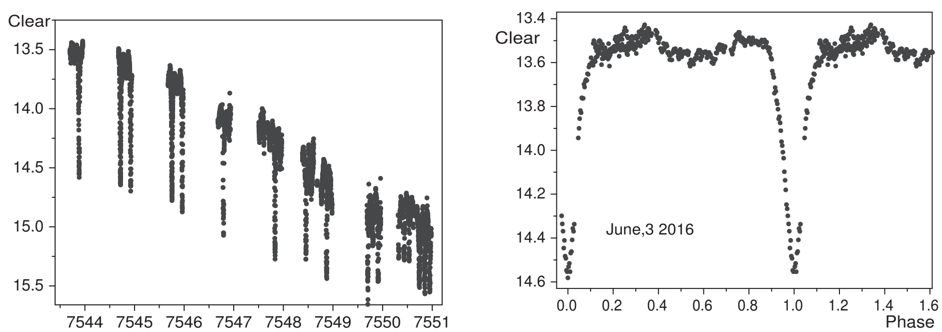

Figure 2. AAVSO data, Clear filter. *Left:* LC of outburst with decline ~0.17 mag/day. *Right:* Phase LC of June 3, 2016.

2. In the Search of Analogues

It is difficult to explain outburst of J1621 in the terms of the model of contact binary. We tried to find the similar objects among the another close binaries. In 1985 Galkina & Shugarov valued the period of the variable star V361 Lyr (~ $0.^{d}30$). Later, after four years of the *UBV*-observations Shugarov et al. (1990) determined the orbital period $0.^{d}309614$. This system has a very asymmetric LCs. The T_1 = 7000–8000 K was calculated for primary component in the paper by Shugarov et al. (1990). Hilditch et al. (1997) determined masses (1.26 and 0.87 M_{sun}) and the temperatures ($T_{1,2}$ = 6200 and 4500 K) of the components and declared about non-evolved components. This star has been a unique for many years. In 2011 another similar object VSX J052807.9+725606 with a period $0.^{d}41179$ was found by Virnina et al. (2011). The hot spots on the stars and flow of matter have a strong influence on the LCs. But LCs of both above objects have clear asymmetry and cannot be the analogs of J1621.

We propose that there is one close binary which may be an analogue of J1621. It is HS 0218+3229, which was classified just as a cataclysmic variable (CV) by Rodriguez-Gil et al. (2009). We observed this star and found one archive (1980) and investigated two new outbursts (2007 and 2011) with amplitude 4 mag. After the study of LCs we classified the star as a dwarf nova with rare symmetric outbursts, which has typical ”inside-out” outbursts and refined the orbital period $0.^{d}297229661$ (Golysheva et al., 2012, 2013; Katysheva et al., 2015). This object was bluer in outburst than in quiescence. Last outburst was in September, 2013 (VSNET). Katysheva et al. (2015) gave examples of LCs of HS 0218+3229 in quiescence. The double wave for the period associated with the ellipsoidal effect. Up now, it has been known for 4 outbursts of HS 0218+3229.

It should be noted that depth minima (primary and secondary) of the light curves of HS0218 + 32 are changed also in quiescence. Sometimes the primary minimum becomes deeper than the primary one.

The difference between these stars is that during outbursts of HS0218+32 the eclipses were not observed. This is due to their different inclination to the line of sight.

It is possible, that J1621 and HS 0218 belong to a new subclass of CVs with large ellipsoidal effect and rare outbursts. Their red components contribute into the luminosity more than an accretion disc and a compact component. In any case, the study of these systems should be continued.

Acknowledgments. The authors are gratefull to President grant NSh-9670/2016/2 .This work was supported by RFBR14–02—00825, 15–02–06178 grants and APVV-15-0458, the VEGA grant No. 2/0008/17. P.G. thanks grant RSF 14-12-00146 for partial support. We also thank the AAVSO for their data.

References

AAVSO site https://www.aavso.org/vsx/index.php?view=detail.top&revid=407170
Cherepashchuk, A. M., 2013, Close binary stars (Moscow: Fizmatgiz)
Drake A. J., Graham, M. J., Djorgovski, S. G., et al. 2014, APJS, 213, 9
Drake, A. J., Djorgovski, S. G., García-Álvarez D., et al. 2014, AJ, 790, 157
Dryomova, G. N., & Svechnikov, M. A. 2006, Astrophysics, 49, 358
Galkina, M., & Shugarov, S.Yu. 1985, Peremennye Zvezdy, 22, 225
Golysheva, P., Antipin, S. V., Zharova, A. V., et al. 2012, Astrophysics, 55, 208
Golysheva, P., Katysheva, N., Shugarov, S., et al. 2013, Central Europ. Astroph. Bull., 37, 345.
Hilditch, R. W., Collier Cameron, A., Hill, G., et al. 1997, MNRAS, 291, 749
Katysheva, N., Shugarov, S., Borisov, N., et al. 2015, Acta Polytechnica CTU Proc., 2(1), 123
Lohr, M. E., Norton, A. J., Kolb, U. C. et al. 2013, A&A, 549, 86
Maehara H. 2016, ATel, 9113
Palaversa, L., Ivezić, Ẑ, Eyer, L., et al. 2013, AJ, 46, 101
Pavlenko, E. P., Sosnovskij, A. A., & Antonyuk, O. I. 2016, ATel, 9138
Pit, N. V., Pavlenko E. P., Antoniuk K. A., et al., this proceedings
Rodriguez-Gil, P., Torres, M. A. P., Gänsicke, B. T., et al. 2009, A&A, 496, 805
Scaringi, S., Mason, E., van Winckel, H., & Escorza, A. 2016, ATel, 9122
Shugarov, S. Yu., Goranskij, V. P., Galkina, M. P., & Lipunova, N. A. 1990, Inf. Bull. Variable Stars, 3472, 1
Thorstensen, J. 2016, ATel, 9141
Virnina, N., Andronov, I. L., & Antonyuk, K. A. 2011, Astrophysics, 54, 392
Zejda, M., & Pejcha, O. 2016, ATel, 9132
Zola, S., Ciprini, S., Debski, B., et al. 2016, ATel, 9167