No.78 **Jul. 2021**

ISSN 0917-2211

Variable Star Bulletin

MGAB-V859 and ZTF18abgjsdg: ER UMa-type dwarf novae showing standstills

Taichi Kato[1] and Naoto Kojiguchi[1]

[1] Department of Astronomy, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan

tkato@kusastro.kyoto-u.ac.jp

Received 2021 Jul. 30

Abstract

Using Public Data Release of Zwicky Transient Facility observations, we found that MGAB-V859 and ZTF18abgjsdg are dwarf novae and show both ER UMa-type and Z Cam-type states. There had been only two dwarf novae showing similar transitions between the ER UMa-type and Z Cam-type states. MGAB-V859 showed both a transition from the ER UMa-type state to a long standstill in 2019 and a Z Cam-type state in 2020. During the standstill in 2020, this object faded twice and showed dwarf nova-type variations. ZTF18abgjsdg usually showed ER UMa-type behavior but standstills were seen in 2018 and 2019. The supercycles of these objects during the typical ER UMa-type phase were 55 d and 58 d, respectively. These objects provide additional evidence that some ER UMa stars indeed bridge between dwarf nova and novalike states as proposed in Kato et al. (2016).

1 Introduction

ER UMa stars are a subclass of SU UMa-type dwarf novae having very short (much less than 100 d) regular supercycles, very short recurrence times of normal outbursts and long duty cycles (Kato and Kunjaya 1995; Robertson et al. 1995; Patterson et al. 1995; for a review, see Kato et al. 1999). The peculiar behavior of ER UMa stars are believed to be basically understood by the thermal-tidal instability (TTI) theory (Osaki, 1989) under the condition of exceptionally high mass-transfer rates ($\dot{M}$) (Osaki, 1995). In dwarf novae with even higher $\dot{M}$, the disk can become thermally stable and standstills in Z Cam stars are considered to be high-$\dot{M}$, thermally stable states.

There have been four known objects that showed both SU UMa-type and Z Cam-type or IW And-type (subtype of Z Cam stars) behavior. Two of them were ER UMa stars.

- The ER UMa star RZ LMi showed long-lasting superoutbursts in 2016–2017 and this behavior was considered to be a state bridging between an ER UMa star and a novalike (or Z Cam) star (Kato et al., 2016).

- The novalike star BK Lyn showed a temporary ER UMa-type state in 2011–2012 (Kemp et al. 2012; Patterson et al. 2013). This state might have already started in 2005–2006 (Kato et al., 2013).

- The SU UMa star NY Ser, which is a system close to an ER UMa star but with supercycles not as regular as in ER UMa stars, showed standstills in 2018 and superoutbursts starting from standstills were observed (Kato et al., 2019). The discovery of superoutbursts starting from standstills provided a clue in understanding still poorly understood IW And-type dwarf novae (Kato 2019; Kimura et al. 2020).

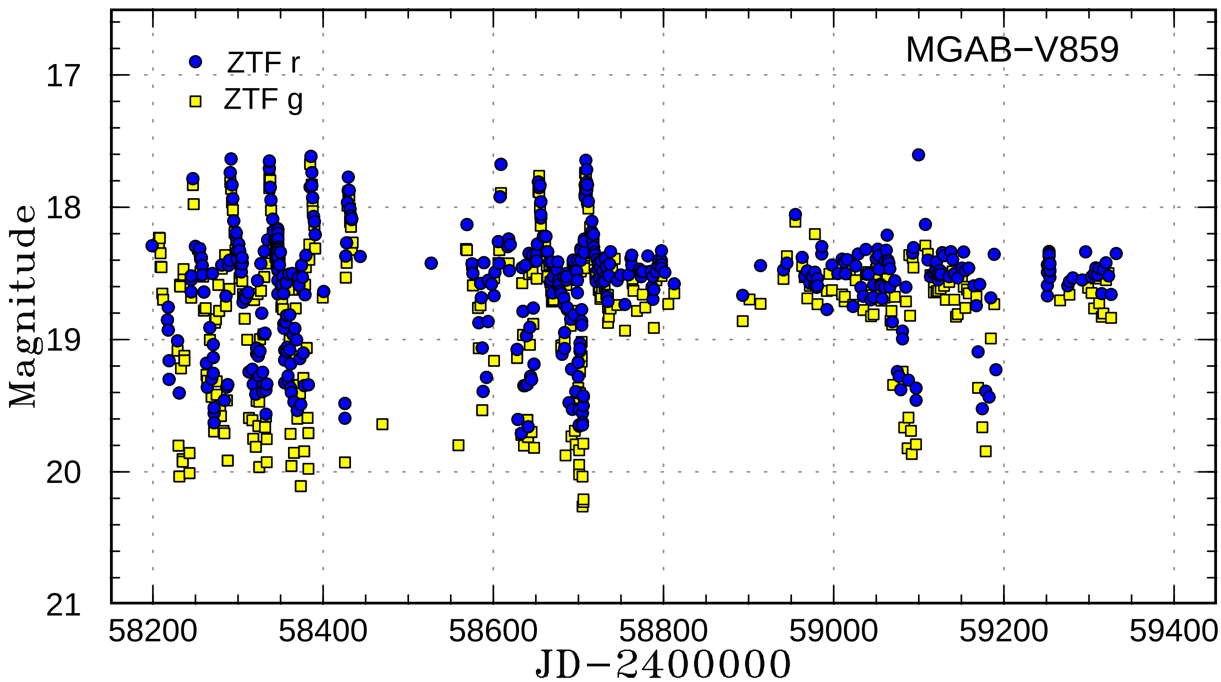

Figure 1: ZTF light curve of MGAB-V859. Both ER UMa-type state and Z Cam state were present.

- BO Cet has recently shown both IW And-type and SU UMa-type states (Kato et al., 2021), but this star is unrelated to an ER UMa star.

We found that two new objects MGAB-V859 (19^{h} 50^{m} 07.038^{s} $+36^{\circ}40'$ $17.24''$, Gaia Collaboration et al. 2021, discovered by Gabriel Murawski) and ZTF18abgjsdg (19^{h} 19^{m} 32.396^{s} $+31^{\circ}48'$ $09.91''$, discovered by Förster et al. 2021) show both ER UMa-type states and Z Cam-type standstills using Public Data Release 6 of the Zwicky Transient Facility (Masci et al., 2019) observations[1] . The peculiar behavior of MGAB-V859 (ER UMa star with a long standstill) had also been suggested by Gabriel Murawski in vsnet-chat 8510 on 2020 October 30[2]

2 MGAB-V859

The entire light curve of MGAB-V859 is shown in figure 1. Both ER UMa-type state and Z Cam-type state were present. The enlargement of the ER UMa-type state is shown in figure 2. Short supercycle (55 d), frequent normal outbursts and the long duty cycle ($\sim$0.5) are characteristic to an ER UMa star. Following the second superoutburst, this object entered a standstill. Figure 3 shows an enlargement of the Z Cam-type state in 2020. In contrast to NY Ser (Kato et al., 2019), this object faded from standstills just as in ordinary Z Cam stars. There was a hint of low-amplitude oscillations with a period of $\sim$10 d just before the termination of the first standstill. This behavior seems to indicate that the disk was becoming thermally unstable before the termination of the standstill.

There were time-resolved observations in ZTF between JD 2459345.68 and 2459346.81, 9–10 d after the peak of the superoutburst. A period analysis using Phase Dispersion Minimization (PDM, Stellingwerf 1978) yielded a possible superhump period of 0.0675(2) d (figure 4). The 1σ error for the PDM analysis was estimated by the methods of Fernie (1989) and Kato et al. (2010). Since the baseline was very short and superhumps in ER UMa stars tend to decay rather quickly (cf. Kato et al. 1996), this period needs to be confirmed by independent observations near the peak of a superoutburst.

[1] The ZTF data can be obtained from IRSA <https://irsa.ipac.caltech.edu/Missions/ztf.html> using the interface <https://irsa.ipac.caltech.edu/docs/program_interface/ztf_api.html> or using a wrapper of the above IRSA API <https://github.com/MickaelRigault/ztfquery>.

[2] <http://ooruri.kusastro.kyoto-u.ac.jp/mailarchive/vsnet-chat/8510>.

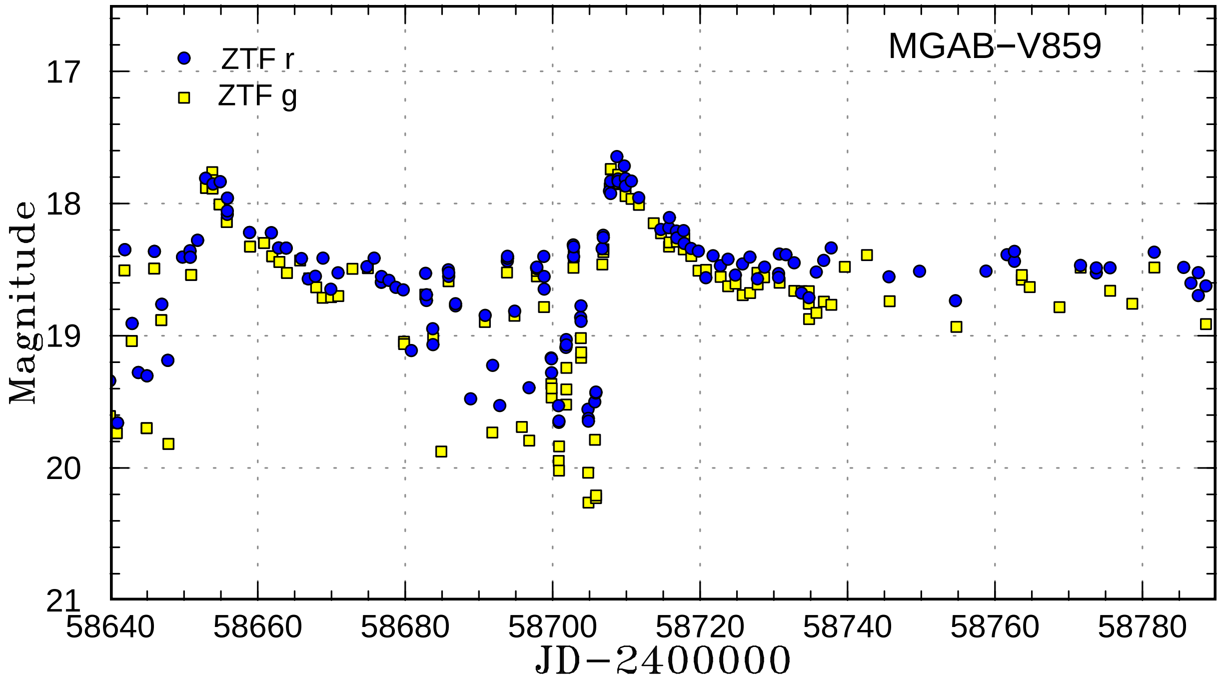

Figure 2: Enlarged ZTF light curve of MGAB-V859. The ER UMa-type state with a long superoutburst followed by frequent normal outbursts (supercycle 55 d) is seen before JD 2458740. The object smoothly entered a standstill following the second superoutburst.

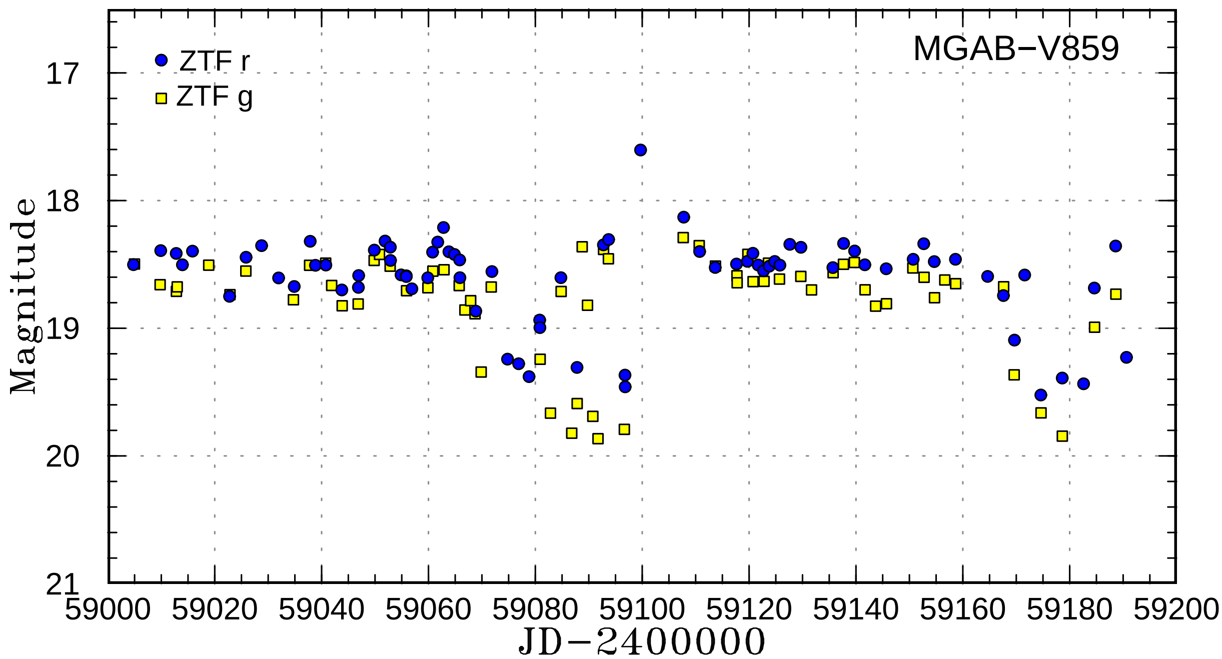

Figure 3: Enlarged ZTF light curve of MGAB-V859 during the Z Cam state in 2020. Standstills were terminated by fading as in ordinary Z Cam stars.

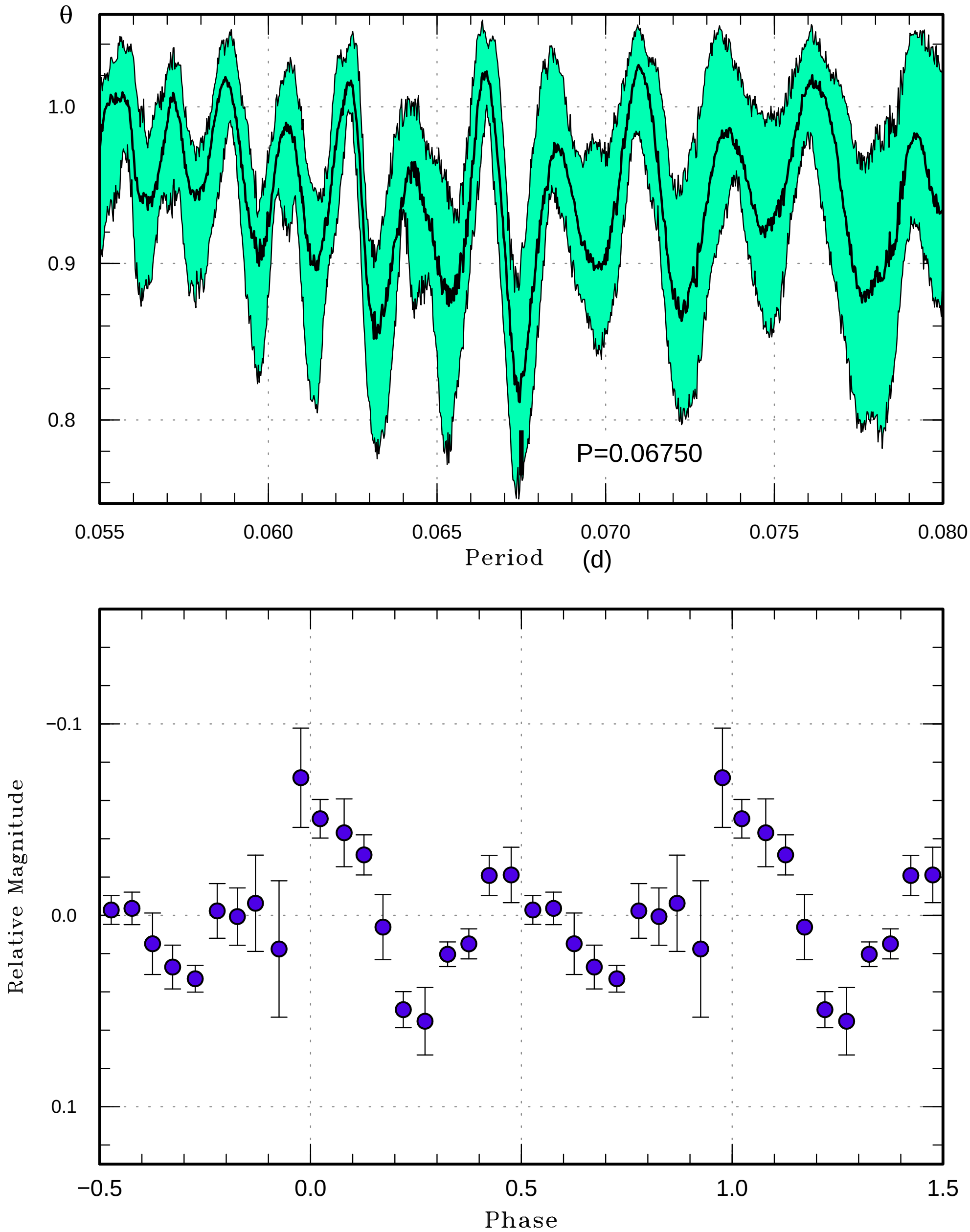

Figure 4: Possible superhumps in MGAB-V859 during a superoutburst from the ZTF time-resolved data. (Upper): PDM analysis. We analyzed 100 samples which randomly contain 50% of observations, and performed the PDM analysis for these samples. The bootstrap result is shown as a form of 90% confidence intervals in the resultant PDM θ statistics. (Lower): Phase-averaged profile.

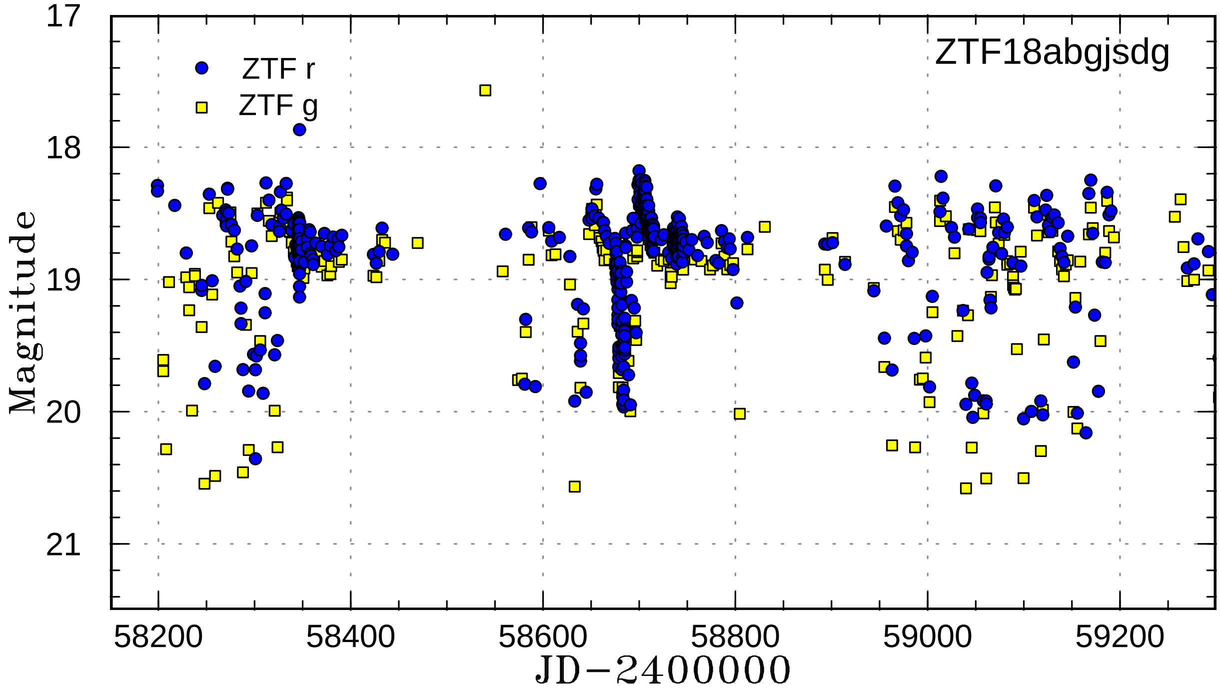

Figure 5: ZTF light curve of ZTF18abgjsdg. Both ER UMa-type state and Z Cam state were present.

3 ZTF18abgjsdg

The case of ZTF18abgjsdg is shown in figure 5. Although the data were less abundant than in MGAB-V859, standstills following superoutbursts on JD 2458326 and 2458699 were recorded. The supercycles were relatively regular (∼58 d) after JD 2458966, but were variable JD 2458720. The variable supercycles were similar to what were observed in RZ LMi in 2016–2017 (Kato et al., 2016) and probably occurred as a result of changing $\dot{M}$.

Although these two objects are very faint, time-resolved observations are encouraged to establish the superhump periods and to study the relation between superhumps and ER UMa-Z Cam transitions.

Acknowledgments

This work was supported by JSPS KAKENHI Grant Number 21K03616.

Based on observations obtained with the Samuel Oschin 48-inch Telescope at the Palomar Observatory as part of the Zwicky Transient Facility project. ZTF is supported by the National Science Foundation under Grant No. AST-1440341 and a collaboration including Caltech, IPAC, the Weizmann Institute for Science, the Oskar Klein Center at Stockholm University, the University of Maryland, the University of Washington, Deutsches Elektronen-Synchrotron and Humboldt University, Los Alamos National Laboratories, the TANGO Consortium of Taiwan, the University of Wisconsin at Milwaukee, and Lawrence Berkeley National Laboratories. Operations are conducted by COO, IPAC, and UW.

The ztfquery code was funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement n°759194 – USNAC, PI: Rigault).

References

Fernie, J. D. 1989, PASP, 101, 225

Förster, F., et al. 2021, AJ, 161, 242

Gaia Collaboration, et al. 2021, A&A, 649, A1

Kato, T. 2019, PASJ, 71, 20

Kato, T., et al. 2013, PASJ, 65, 23

Kato, T., et al. 2016, PASJ, 68, 107

Kato, T., & Kunjaya, C. 1995, PASJ, 47, 163

Kato, T., et al. 2010, PASJ, 62, 1525

Kato, T., Nogami, D., Baba, H., Masuda, S., Matsumoto, K., & Kunjaya, C. 1999, in Disk Instabilities in Close Binary Systems, ed. S. Mineshige, & J. C. Wheeler (Tokyo: Universal Academy Press), p. 45

Kato, T., Nogami, D., & Masuda, S. 1996, PASJ, 48, L5

Kato, T., et al. 2019, PASJ, 71, L1

Kato, T., et al. 2021, PASJ, in press (arXiv:2106.15028)

Kemp, J., et al. 2012, in Proc. 31st Annu. Conf., Symp. on Telescope Science, ed. B. D. Warner, & et al. (Rancho Cucamonga, CA: Society for Astronomical Sciences), p. 7

Kimura, M., Osaki, Y., Kato, T., & Mineshige, S. 2020, PASJ, 72, 22

Masci, F.-J., et al. 2019, PASP, 131, 018003

Osaki, Y. 1989, PASJ, 41, 1005

Osaki, Y. 1995, PASJ, 47, L11

Patterson, J., Jablonski, F., Koen, C., O'Donoghue, D., & Skillman, D. R. 1995, PASP, 107, 1183

Patterson, J., et al. 2013, MNRAS, 434, 1902

Robertson, J. W., Honeycutt, R. K., & Turner, G. W. 1995, PASP, 107, 443

Stellingwerf, R. F. 1978, ApJ, 224, 953

VSOLJ
c/o Keiichi Saijo National Science Museum, Ueno-Park, Tokyo Japan

Editor Seiichiro Kiyota
e-mail: skiyotax@gmail.com