The 2006 November outburst of EG Aquarii: the SU UMa nature revealed

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Abstract

We report time-resolved CCD photometry of the cataclysmic variable EG Aquarii during the 2006 November outburst. During the outburst, superhumps were unambiguously detected with a mean period of 0.078828(6) days, firstly classifying the object as a SU UMa-type dwarf nova. It also turned out that the outburst contained a precursor. At the end of the precursor, immature profiles of humps were observed. By a phase analysis of these humps, we interpreted the features as superhumps. This is the second example that the superhumps were shown during a precursor. Near the maximum stage of the outburst, we discovered an abrupt shift of the superhump period by $\sim$ 0.002 days. After the supermaximum, the superhump period decreased at the rate of $\dot{P}/P = -8.2 \times 10^{-5}$, which is typical for SU UMa-type dwarf novae. Although the outburst light curve was characteristic of SU UMa-type dwarf novae, long-term monitoring of the variable shows no outbursts over the past decade. We note on the basic properties of long period and inactive SU UMa-type dwarf novae.

Key words: accretion, accretion disks — stars: dwarf novae — stars: individual (EG Aquarii) — stars: novae, cataclysmic variables — stars: oscillations
1. Introduction

Dwarf novae are a subclass of cataclysmic variables (CVs) that consist of a white dwarf primary and a late-type secondary. The secondary fills its Roche lobe and transfers gases into the primary through the inner Lagrangian point (L1). The transferred matter forms an accretion disk around the white dwarf. The accretion disk causes instabilities, which are observed as an outburst (for a review, see Warner 1995; Osaki 1996; Hellier 2001; Connon Smith 2007).

SU UMa-type stars are a subclass of dwarf novae. The majority have orbital periods below 2 hours. This subclass exhibits two types of outbursts. One is a normal outburst, lasting a few days. The other is a superoutburst lasting about 2 weeks. The most characteristic feature during the superoutburst is that the light curve always shows modulations termed superhump. The observed period of superhumps is a few percent longer than the orbital period of the system. This is well explained by the precessing eccentric disk, which is deformed at the 3:1 resonance radius (Whitehurst 1988; Osaki 1989).

EG Aquarii (hereafter EG Aqr) was introduced as a candidate for dwarf novae by Luyten, Haro (1959) and later by Vogt, Bateson (1982). The variability of EG Aqr was reported in Haro, Chavira (1960), in which the variable was at 14.0 mag on 1958 November 5. There are no other positive and negative observations except this around this outburst, so that we cannot lead to the conclusion of the nature of the outburst. Szkody, Howell (1992) performed optical spectroscopy of the variable. The result was, however, that the spectrum showed no emission in Balmer series. On the contrary, it resembles that of a K-type star. There is a possibility that the star was simply misidentified by Szkody, Howell (1992). Our astrometric estimation of the variable from the outbursting images yielded RA 23°25′19″.09 and Dec −08°18′18″.5, respectively. This means that the variable is identical with USNO B1.0 0816-0716959 (RA 23°25′19″.17, Dec −08°18′18″.9, B1=18.760 R1=18.260). Concerning these results, the infrared counterpart may be 2MASS J23251917-0818190 (J=17.432, H=16.309, K=15.681). As for the X-ray range, the variable is below the detection limit of the ROSAT faint source catalog (Voges et al. 1999).

On 2006 November 8, one of the authors (RS) discovered the eruption of EG Aqr at a visual magnitude of 12.5 ([vsnet-alert 7217]). This is the first record of outburst since the report by Haro, Chavira (1960). Here we report on time-resolved CCD photometry of EG Aqr during the 2006 November superoutburst.

2. Observations

Time resolved CCD photometry was performed on 15 nights using 25-150cm telescopes between 2006 November 8 and 2006 December 6 at 8 sites, and a log of observations is summarized in table 1. No filter was used except for Higashi-Hiroshima site and the obtained data were close to those of Rc-system. At Higashi-Hiroshima site, the data were obtained with the Triple Range Imager and Spectrograph (TRISPEC, Watanabe et al. 2005) using a V filter on 2006 November 21, December 5, and December 6. The exposure time was 10-63 seconds, with a few second readout time of the CCDs. The total datapoint amounts to 10506, which is sufficient to investigate the variability of the system.

After debiasing and flat fielding, the images were processed by aperture photometry packages. Since there existed an effect of the atmospheric extinction due to the color difference between the variable and the comparison star, we made a correction for the data. After correcting the obtained magnitudes between sites, the magnitude was adjusted to that of the Kyoto site, where we used a Java-based aperture photometry package developed by one of the authors (TK). The differential magnitude of the variables were determined using No. 12 of the Henden Catalog (V=11.910, B − V=0.632), whose constancy was checked using nearby stars in the same images. The accuracy of the calibration was dependent on the condition of the skies. Although some data were contaminated by such as clowds or light pollutions, the expected error was achieved as small as 0.03 mag for good data, which is sufficient for the purpose of our observations. Heliocentric correction was made for each data set before the following analyses.

3. Results

3.1. Light Curves

Figure 1 illustrates the overall light curves of EG Aqr during the 2006 outburst. By virtue of the prompt reports of the outburst, the data covered the early stages before the outburst maximum. Enlarged light curves around the maximum are displayed in figure 2. Judging from the trend of the light curve, we may have caught the end of the precursor and rising stage of the main outburst on HJD 2454048. At the end of the precursor, some superhumps were visible. The magnitude reached the maximum on HJD 2454049, after which the variable declined at the rate of 0.14(1) mag d−1. Based on its quiescent and maximum magnitude, the superoutburst amplitude exceeded ~5.8 mag. From this, we can categorize EG Aqr as large-amplitude dwarf novae (TOADs, Howell et al. 1995). The duration of the plateau stage was 8-11 days. No rebrightenings were observed during our run.

3.2. Superhump

To clarify EG Aqr as a new member of SU UMa-type dwarf novae, we examined the light curves obtained at each site. Except for some data obtained under bad conditions, we can unambiguously detect superhumps having a rapid rise and slow decline of the profiles. This is the

\footnote{ftp://ftp.aavso.org/public/calib/}
Fig. 1. Light curve of EG Aqr during the 2006 November superoutburst. The abscissa and the ordinate denote HJD and relative magnitude, respectively. The comparison star is at a magnitude of 11.91 in $V$ band. The filled and open circles indicate an averaged light curves obtained by our run and the AAVSO database, respectively. The bottom triangles denotes negative observations reported to the AAVSO and VSNET. A precursor was detected on HJD 2454048 (see also figure 2). The maximum magnitude was reached around HJD 2454049.7, after that the variable declined at the rate of 0.14(1) mag d$^{-1}$. No evidence for a rebrightening was shown during our whole run.

Fig. 2. Enlarged light curves around the supermaximum. For the purpose of description, data obtained from HJD 2454048.8877 to HJD 2454049.1369 were binned by 8 frames. Although the data were sparse before HJD 2454048.5, the light curves provided evidence for a precursor around the phase, where a hint of modulations was visible. As can be seen in this figure, the supermaximum was around HJD 2454049.7.
first time that EG Aqr showed superhumps. After subtracting trends for each light curve, we applied the phase dispersion minimization method (PDM, Stellingwerf 1978) to the residual light curves from HJD 2454049.5 to HJD 2454057, corresponding to the plateau stage. The resultant theta diagram is displayed in figure 3, in which we determined 0.078828(6) days as the best estimated period of the mean superhump. The error of the period is calculated using the Lafler-Kinman class of methods, as applied by Fernie (1989). The same method was applied for the data before HJD 2454049.5, from which we determined $P=0.08076(11)$ days as being the best estimated period. Figure 4 shows the resultant theta diagram. These results indicate the mean superhump period around the maximum was about 0.002 days longer than that during the main plateau stage. In figure 5, we demonstrate the averaged profiles of the superhumps folded by 0.08076 days from HJD 2454049 and 0.078828 days for HJD 2454050 through HJD 2454057, where one can see a characteristic feature of superhumps. Although the amplitude of the superhumps decreased as the superoutburst proceeded, the shape of the profiles kept almost constant over the course of the plateau stage. The apparent absence of eclipses indicates that the inclination of the system is not too high.

| Date       | HJD-start* | HJD-end* | Exp(s)† | N‡ | ID§  |
|------------|------------|----------|---------|----|------|
| November 8 | 48.2507    | 48.2719  | 30      | 57 | BM   |
|           | 48.3433    | 48.4689  | 60      | 161| GM   |
| November 9 | 48.5502    | 48.7896  | 30      | 559| KTC  |
|           | 48.8877    | 49.1369  | 30      | 140| Njh  |
|           | 49.0311    | 49.0906  | 30      | 285| Kyoto|
|           | 49.2279    | 49.3960  | 60      | 212| GM   |
|           | 49.3272    | 49.4042  | 30      | 219| BM   |
| November 10| 49.5484   | 49.7925  | 30      | 570| KTC  |
|           | 50.2290    | 50.4390  | 60      | 233| GM   |
| November 11| 50.5497   | 50.8028  | 30      | 591| KTC  |
|           | 50.9310    | 50.9632  | 30      | 39 | Njh  |
| November 12| 51.8683   | 52.0512  | 30      | 390| Kyoto|
|           | 51.8824    | 52.0413  | 30      | 280| Njh  |
|           | 51.8851    | 51.9495  | 30      | 142| Kis  |
|           | 51.9244    | 52.1404  | 30      | 749| Mhh  |
| November 13| 52.5921   | 52.8031  | 30      | 493| KTC  |
|           | 52.9314    | 52.9988  | 30      | 109| Njh  |
|           | 53.0267    | 53.0671  | 30      | 71 | Kyoto|
| November 14| 53.5503   | 53.8013  | 30      | 586| KTC  |
|           | 53.9061    | 54.0310  | 30      | 410| Mhh  |
| November 15| 54.8652   | 55.0377  | 30      | 227| Kyoto|
|           | 54.9020    | 55.0546  | 30      | 281| Njh  |
|           | 55.2578    | 55.4017  | 60      | 177| GM   |
| November 16| 55.5533   | 55.8009  | 30      | 578| KTC  |
|           | 55.8599    | 56.0782  | 30      | 338| Kyoto|
|           | 55.8835    | 56.0688  | 30      | 312| Njh  |
| November 17| 56.6015   | 56.7992  | 30      | 462| KTC  |
|           | 56.8768    | 57.1001  | 30      | 350| Kyoto|
|           | 56.8834    | 56.9822  | 30      | 180| Njh  |
| November 18| 57.5465   | 57.7572  | 30      | 351| KTC  |
| November 20| 59.8828   | 60.0813  | 30      | 265| Kyoto|
| November 21| 61.0241   | 61.1100  | 63      | 81 | Kanata|
| November 24| 63.9465   | 64.0325  | 10      | 606| Kanata|
| December 5 | 74.9825   | 75.0276  | 63      | 48 | Kanata|
| December 6 | 76.0116   | 76.0383  | 63      | 26 | Kanata|

*HJD-2454000. †Exposure time. ‡Number of exposure. §Observer’s ID.

BM: L.A.G. Monard, South Africa. GM: G. Masi, Italy.
KTC: T. Krajci, USA. Njh: K. Nakajima, Japan.
Kyoto: A. Imada et al., Japan. Kis: S. Kiyota, Japan.
Mhh: H. Maehara, Japan. Kanata: M. Uemura et al., Japan.
3.3. superhump period change

We calibrated the maximum timings of superhumps mainly by eye. The error is an order of 0.001 days. In table 2, we tabulate the maximum timings of superhumps. A linear regression to the obtained values in table 2 yielded,

$$HJD_{\text{max}}(\text{max}) = 2454048.7101(18) + 0.078935(29) \times E,$$

where $E$ is the cycle count. Using the equation, we can draw an $O-C$ diagram described in figure 6. It should be noted that the change of the period occurred for $8 \leq E \leq 11$, when we missed observations unfortunately. Nevertheless, we firstly succeeded in detecting the superhump period change at the early stage of superoutburst for long-period SU UMa-type dwarf novae, and confirmed the period change did occur. For $-4 < E < 8$, the best fit equation is given by

$$O - C = -1.40(0.09) \times 10^{-2} + 2.35(0.18) \times 10^{-3} E.$$  \hspace{1cm} \text{(2)}

On the other hand, the best fit quadratic between $E=11$ and $E=114$ is given by

$$O - C = 2.37(0.90) \times 10^{-3} + 2.52(0.33) \times 10^{-4} E - 3.23(0.26) \times 10^{-6} E^2.$$  \hspace{1cm} \text{(3)}

The equation 3 indicates $P_{\text{dot}} = \dot{P}/P = -8.2(7) \times 10^{-5}$. This is a normal value for SU UMa-type dwarf novae (Imada et al. 2006).

3.4. post outburst stage

Some SU UMa-type dwarf novae exhibit rebrightenings and/or late superhumps after the main plateau stage. In order to search for these phenomena, we mainly used 1.5m Kanata telescope. Figure 7 shows the representative light curves after the main plateau stage obtained by the telescope. One can see modulations with an amplitude larger than 0.3 mag, which is even larger than that of superhumps. On November 24, the light curve appears to be doubly-peaked indicating the light curve had remained unchanged. However, due to the lack of observations, it is not clear whether the observed light curves are late superhumps.  \footnote{We calibrated the maximum timing of the hump on November 24. However, we cannot draw firm conclusion whether a phase shift occurred, since the interval between the two successive humps was too long (see table 2).}

In order to explore whether a rebrightening showed, we examined the VSNET and AAVSO databases. As can be seen in figure 1, there is no evidence for a rebrightening before HJD 2454065. Although most of rebrightenings are observed within 5 days after the end of the plateau stage (e.g., Howell et al. 1996; Ishioka et al. 2001; Templeton et al. 2006), we cannot rule out the possibility that a rebrightening occurred between HJD 2454066 and HJD 2454070.

4. Discussion

4.1. long-term activity

One of the most unique properties in EG Aqr is the inactivity of the system. As mentioned before, there is only one recorded outburst since the discovery of EG Aqr until the current one. No outbursts were detected by the ASAS-3 over the past 5 years, during which the variable was below the detection limit of $V=14.5$. We also explored visual observations reported to the AAVSO and VSNET since 1999. EG Aqr was especially monitored in 1999, 2000, and 2004 with a mean interval of observations being a few days. These intensive observation may detect not only superoutburst but also normal outburst if they really occur. However, no outbursts were reported until 2006. Although we should await an investigation on archival plates to draw a firm conclusion as to whether EG Aqr is indeed inactive, the current available information on EG Aqr may suggest its inactive nature.
support its long recurrence time, since the frequency of normal outburst is related to the length of the supercycle (Osaki 1995).

4.2. outburst light curve

As noted above, extensive CCD photometry revealed the SU UMa nature of EG Aqr. Superhumps were clearly visible during the course of the superoutburst for the first time in EG Aqr. As for the light curve itself, we should note on the presence of a precursor and the presence of superhumps at the end of the precursor. In the previous section, we have shown the $O-C$ diagram, in which we measured the maximum timings at the end of the precursor, corresponding to $E=-4$ and -3. The obtained $O-C$ diagram strongly suggests that the light source of the variations in $-4 < E < 8$ comes from the same origin, since a phase shift or a change of the period were not seen. This means that the modulations were coherent for $-4 < E < 8$.

As can be seen in figure 2 the modulations that we observed around $E = 8$ were genuine superhumps. Therefore, it is likely that superhumps had already grown at the end of the precursor. If this is the case, EG Aqr is the second example that superhumps were seen even during a precursor, following the 1993 superoutburst of T Leo (Kato 1997).

Besides the presence of the superhumps during the precursor, the overall light curve is typical of SU UMa-type dwarf novae, in terms of the duration of the plateau phase, as well as the decline rate of the magnitude. The presence of a precursor also supports its SU UMa nature of EG Aqr, since no precursor has been reported for WZ Sge-type dwarf novae (Kato et al. 2004).

4.3. superhump period change

As is well known, most of SU UMa-type dwarf novae decrease their superhump period during the course of the plateau stage. This is due to shrinkage of the disk, or a natural consequence of the depletion of the mass (Osaki 1985). Recent studies, however, have shown that some systems increase the superhump period during the plateau phase (Nogami et al. 1997). So far, the exact mechanism that causes the superhump period change is not known.

Recently, Uemura et al. (2005) has suggested that the superhump period change may be related to the presence or absence of a precursor. The authors studied a short period SU UMa-type dwarf nova TV Crv for the 2002 and 2004 superoutburst, and discovered that the superhump period increased during the 2002 superout-

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### Table 2. Timings of superhump maxima.

| $E^*$ | HJD$^\dagger$ | err$^\dagger$ | ID | $E^*$ | HJD$^\dagger$ | err$^\dagger$ | ID |
|-------|---------------|------------|----|-------|---------------|------------|----|
| -4    | 48.3731       | 0.003      | GM | 51    | 52.7400       | 0.005      | KTC|
| -3    | 48.4498       | 0.007      | GM | 54    | 52.9823       | 0.001      | Njh|
| -1    | 48.6112       | 0.005      | KTC| 62    | 53.6106       | 0.002      | KTC|
| 0     | 48.6979       | 0.001      | KTC| 63    | 53.6891       | 0.005      | KTC|
| 1     | 48.7763       | 0.003      | KTC| 64    | 53.7696       | 0.002      | KTC|
| 3     | 48.9428       | 0.002      | Kyoto| 66  | 53.9246       | 0.008      | Mhh|
| 4     | 49.0257       | 0.004      | Kis| 67    | 54.0058       | 0.004      | Mhh|
| 5     | 49.1018       | 0.004      | Mhh| 79    | 54.9487       | 0.002      | Kyoto|
| 7     | 49.2623       | 0.003      | GM | 79    | 54.9498       | 0.003      | Njh|
| 8     | 49.3448       | 0.001      | AAVSO| 80  | 55.0256       | 0.003      | Njh|
| 8     | 49.4365       | 0.002      | GM | 83    | 55.2631       | 0.005      | GM |
| 8     | 49.5827       | 0.002      | KTC| 87    | 55.5774       | 0.002      | KTC|
| 12    | 49.6628       | 0.003      | KTC| 88    | 55.6556       | 0.002      | KTC|
| 13    | 49.7414       | 0.002      | KTC| 89    | 55.7334       | 0.002      | KTC|
| 20    | 50.2950       | 0.001      | GM | 91    | 55.8915       | 0.003      | Kyoto|
| 21    | 50.3746       | 0.001      | GM | 92    | 55.9683       | 0.002      | Kyoto|
| 24    | 50.6118       | 0.001      | KTC| 92    | 55.9705       | 0.005      | Njh|
| 25    | 50.6893       | 0.002      | KTC| 93    | 56.0482       | 0.002      | Njh|
| 26    | 50.7710       | 0.001      | KTC| 101   | 56.6770       | 0.004      | KTC|
| 41    | 51.9526       | 0.002      | Njh| 102   | 56.7557       | 0.004      | KTC|
| 41    | 51.9530       | 0.002      | Mhh| 104   | 56.9133       | 0.003      | Kyoto|
| 41    | 51.9535       | 0.002      | Kyoto| 104 | 56.9156       | 0.005      | Njh|
| 42    | 52.0311       | 0.004      | Mhh| 105   | 56.9891       | 0.003      | Kyoto|
| 42    | 52.0322       | 0.003      | Njh| 113   | 57.6194       | 0.001      | KTC|
| 43    | 52.1104       | 0.003      | Mhh| 114   | 57.6985       | 0.002      | KTC|
| 50    | 52.6610       | 0.002      | KTC| 194:  | 63.9761       | 0.004      | Kanata|

$^\ast$ Cycle count.
$^\dagger$ HJD-2454000
$^\ddagger$ In the unit of day.
burst without a precursor, while hardly changed during the 2004 superoutburst with a precursor. Theoretically, Osaki, Meyer (2003) proposed the refined thermal-tidal instability model, in which a superoutburst without a precursor have a larger disk radius than that with a precursor. When the accretion disk reaches the tidal truncation radius as a result of the mass accretion onto the white dwarf, the stored matter at the outer edge may prevent the inner propagation of the cooling wave, so that the disk keeps the hot state. On the other hand, if the accretion disk does not reach the tidal truncation radius, the outermost region of the disk allows the cooling wave to propagate inward. As a consequence, the outburst is quenched like a normal one. If the eccentricity of the accretion disk grows sufficiently, the tidal dissipation at the rim of the disk leads to the orientation of the heating wave. This process is observed as a superoutburst with a precursor.

In the case of EG Aqr, the superoutburst was accompanied by a precursor, indicating that the radius of the accretion disk did not reach the tidal truncation radius. This, however, seems to be peculiar when taking into account the long quiescent time of the object. The long

Fig. 5. Nightly averaged profiles of superhumps. The numbers in this figure denote the days since HJD 2454000. Based on the above estimated period, the profile on HJD 2454049 was folded by 0.08076 days, while folded by 0.078828 days after HJD 2454050. Although the amplitude of the superhumps decreased gradually, the feature of a rapid rise and slow decline were visible for all the respective nights.

Fig. 6. $O-C$ diagram during the superoutburst. The horizontal and vertical axes mean $O-C$ and the cycle count, respectively. The maximum timings were listed in table 2. A linear regression to the observed times gives equation (1). The solid and dashed lines indicate the best fit equation for $-4 < E < 8$ and $11 < E < 110$, respectively. The former is given by equation (2), while the latter is given by equation (3). This figure means that the period kept almost constant in $-4 < E < 8$. However, an abrupt period change occurred in $8 < E < 11$. After $E > 11$, the superhump period decreased gradually at the rate of $\dot{P}/P = -8.2 \times 10^{-5}$.

Fig. 7. Representative light curves during the post-outburst phase. For a visual purpose, these light curves were arbitrarily shifted. The numbers in the figure denote the days from 2454000. The datapoints are binned by 4 frames on HJD 2454063 (November 24) after precluding the bad data. There exist large modulations on both light curves.
quiescence means a large amount of mass in the accretion disk, like WZ Sge-type dwarf novae. However, the duration of the plateau stage, as well as the presence of a precursor are indicative of the small disk of the object compared to WZ Sge-type dwarf novae.

During the main plateau stage, the best fitting quadratic formula yielded \( P_{\text{tot}} = \frac{P}{P} = -8.2 \times 10^{-5} \), which is a normal value for SU UMa-type dwarf novae. The value is quite different from that observed in WZ Sge-type stars, which show positive period derivatives, or almost constant value of the superhump periods (Ishikawa et al. 2003). Although quiescence of EG Aqr behaves as WZ Sge-type dwarf nova, the overall feature of the superhump period changes and the light curve of the superoutburst bear strong resemblance to those of usual SU UMa-type dwarf novae.

Regarding the early phase of the observations, it again should be noted that the superhump period unchanged and a sort of period change occurred near the bright maximum. Although evidence of such period changes has been provided in other SU UMa-type dwarf novae (e.g., figure 5 of Uemura et al. (2005)), this is the first case that we specify when the transition occurred. In future, we should investigate whether the period change is a ubiquitous property for SU UMa-type dwarf nova by observing other objects, which shed lights on understanding the origin of the period shift.

4.4. inactive SU UMa-type dwarf novae with long superhump periods

So far, as much as 200 objects have been confirmed to be SU UMa-type dwarf novae, for which we may divide them into two categories according to their superhump periods and their tendency of the period derivatives. There exists a rough cutoff around \( P_{\text{sh}} = 0.063 \) days below which the superhump period tends to increase during the superoutburst (Imada et al. 2005). On the other hand, for systems above \( P_{\text{sh}} = 0.063 \) days, where the majority of SU UMa-type dwarf novae exists, the superhump period tends to decrease or keep almost constant. The latter systems are sometimes introduced as “textbook” SU UMa-type dwarf novae (Kato et al. 2003).

However, when we focus on the long-term behavior of the respective system, we notice the diversity of the nature. For example, a prototype SU UMa-type star VW Hyi shows frequent normal outbursts between two successive superoutbursts with a mean recurrence time of the superoutburst being 150 days (Osaki 1989). Such systems are well reproduced by the thermal-tidal instability model (Osaki 1989; Osaki, Meyer 2003). Some long-period systems, on the other hand, hardly show not only a normal outburst, but also a superoutburst. These systems include EF Peg (Howell et al. 1993; Kato 2002; Howell et al. 2002), V725 Aql (Hazen 1996; Uemura et al. 2001), QY Per\(^5\), and EG Aqr. All of these systems have a long recurrence time of years, indicating that the mass transfer rate from the secondary is supposed to be small. This seems to be curious because the secular evolution of dwarf novae suggests the existence of relatively high mass secondaries compared to those in short period dwarf novae unless the binaries are so called “period bouncers” (King 1988; Kolb, Baraffe 1999; Patterson et al. 2005). It is unlikely that these systems had passed the period minimum of dwarf novae, since the evolutional timescale for “period bouncers” may be as long as ~ 10 Gyrs (Patterson 1998). Optical and infrared spectroscopy show mid M-type secondaries in EF Peg (Howell et al. 2002). This indicates that this system does not reach the period minimum, because the “period bouncers” are believed to contain a brown dwarf secondary (Howell et al. 1997).

At present, we cannot specify the reason why such inactive systems do exist in long period systems. In fact, these systems are less studied, especially during quiescence. Actually, we have no information on the orbital period of the above four systems.\(^6\) In future, quiescent spectroscopy is imperative in order to determine the orbital period and the spectral type of the secondary of the system. This would shed some light on the evolutionary status of the above mentioned systems.

5. Conclusion

We established the SU UMa nature of EG Aqr for the first time by the detection of the superhumps with a mean period of 0.078828(6) days. The observed superoutburst showed a precursor, during which a hint of superhumps was seen at the last stage of the precursor. Extensive observations enabled us to examine detailed changes of the superhump period. It turned out that the superhump period kept almost constant near the bright maximum, after which the superhump period decreased normally at the rate of \( P_{\text{tot}} = \frac{P}{P} = -8.2 \times 10^{-5} \) all over the plateau stage. Although the origin is unknown, we detected a change of the period near the bright maximum. Concerning the observed period change and the presence of the precursor, the maximum radius of the accretion disk was not large during the superoutburst. The obtained light curves were typical of those of SU UMa-type dwarf novae. This is definitely peculiar when taking into account that EG Aqr showed only one recorded eruption until the 2006 superoutburst. Despite the inactivity of the variable, we conclude that EG Aqr is a new member of SU UMa-type dwarf novae. In future, quiescent studies both from photometry and spectroscopy are imperative in order to further understand the enigmatic object.

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