Study of Negative and Positive Superhumps in ER Ursae Majoris

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(Received 2010; accepted 2010)

Abstract

We carried out the photometric observations of the SU UMa-type dwarf nova ER UMa during 2011 and 2012, which showed the existence of persistent negative superhumps even during the superoutburst. We performed two-dimensional period analysis of its light curves by using a method called “least absolute shrinkage and selection operator” (Lasso) and “phase dispersion minimization” (PDM) analysis, and we found that the period of negative superhumps systematically changed between a superoutburst and the next superoutburst. The trend of the period change can be interpreted as reflecting the change of the disk radius. This change of the disk radius is in good agreement with the predicted change of the disk radius by the thermal-tidal instability (TTI) model. The normal outbursts within a supercycle showed a general trend that the rising rate to maximum becomes slower as the next superoutburst approaches. The change can be interpreted as the consequence of the increased gas-stream flow onto the inner region of the disk as the result of the tilted disk. Some of the superoutbursts were found to be triggered by a precursor normal outburst when the positive superhumps appeared to develop. The positive and negative superhumps co-
1. Introduction

Dwarf novae (DNe) are a class of cataclysmic variables (CVs), which consist of a white dwarf primary and a late-type secondary which fills its Roche lobe. The material transferred toward the primary through the inner Lagrangian point (L1) forms an accretion disk around the white-dwarf. The accretion disk causes instabilities, which are observed as an outburst [for reviews, see Warner (1995); Osaki (1996); Hellier (2001)]. SU UMa-type stars are a subgroup of dwarf novae. They are characterized by the presence of two types of outbursts, normal outburst and superoutburst. Whereas a normal outburst lasts for only a few days, a superoutburst lasts for about two weeks and the maximum magnitude of the latter is brighter by 0.5–1 mag.

The interval of successive two superoutbursts is called “supercycle”. These two superoutbursts usually sandwich several normal outbursts. In order to explain such behavior of SU UMa-type dwarf novae, the tidal thermal instability (TTI) model is suggested (Osaki 1989). In this model, systems with small mass ratios \( M_2/M_1 = q \leq 0.25 \) enable the disk to reach the radius of the 3:1 resonance to the orbital motion of the secondary. In normal outbursts, the material of the disk only partly accrete to the inner region. Whereas the radius of the disk becomes gradually larger after experiencing normal outburst. When the disk radius reaches the 3:1 resonance radius, the eccentric instability is excited. The increased turbulence in the disk causes an increase in the mass-transfer rate in the disk and a long, bright superoutburst is triggered (Osaki 1989). This prograde precession also causes the superhump (Whitehurst 1988, Hirose, Osaki 1990).

ER UMa is a member of SU UMa-type dwarf novae and its intervals of superoutburst (supercycle) are as short as \( 40 – 50 \) d (Kato, Kunjaya 1995). This object is known as the prototype of a subgroup, “ER UMa type” which is characterized by having extremely short supercycles (< 60 d) among SU UMa-type stars (e.g. Robertson et al. 1995, Nogami et al. 1995; for a review see Kato et al. 1999). Although Gao et al. (1999) and Kjurkchieva, Marchev (2010) suggested on the presence of negative superhumps during quiescence and a normal outburst, only positive superhumps were observed during the following superoutburst. However, Ohshima et al. (2012) reported that negative superhumps were detected in ER UMa during the superoutburst in 2011 January. This is the first confident detection of negative superhumps during the superoutburst of any SU UMa-type dwarf nova. In Ohshima et al. (2012) (hereafter paper I), we reported the persistent negative superhump was detected in ER UMa and implied the possibility that the existence of negative superhumps suppresses of the occurrence of normal outbursts.

The existence of negative superhumps during superoutburst was also reported in other SU UMa-type dwarf novae V1504 Cyg and V344 Lyr (Osaki, Kato 2013a, Still et al. 2010). Osaki, Kato (2013a) analyzed data of an SU UMa-type dwarf nova V1504 Cyg observed by Kepler, and showed that this object also shows negative superhumps during superoutburst as well as during normal outbursts and in quiescence. Osaki, Kato (2013a) have demonstrated that in V1504 Cyg the frequency of occurrence of normal outbursts in a supercycle is related to the existence or non-existence of negative superhumps in the sense that it is reduced when the negative superhumps exist, confirming the suggestion made in Paper I. That is, the cycle lengths of normal outbursts are longer in a supercycle with negative superhumps than those in a supercycle without negative superhumps, and they called the former case “type L-supercycle” and the
latter case “type S-supercycle” (these two types were first introduced by Smak (1985) for supercycles observed in VW Hyi and symbols “L” and “S” come from “long” and “short” for normal outburst cycles).

In Paper I, we dealt with only one supercycle of ER UMa in 2011. We have made further comprehensive observations of ER UMa in 2011 and 2012 and, our data covered three supercycles in 2011 and three supercycles in 2012. All of supercycles observed have turned out to be were all accompanied with negative superhumps, and provide an excellent opportunity to study the outburst behavior when negative and positive superhumps co-exist. In this paper, we report on these new observations together with a more sophisticated analysis of the data reported in paper I. We explain our observations in section 2 and we present the result of their analysis observation and analysis in section 3. The conclusion is given in section 4.

2. Observations

We performed time-resolved photometric observations of ER UMa at 21 observatories scattered world-wide from 2011 January to 2012 December as a part of the VSNET Collaboration (Kato et al. 2004). We could obtain data of 146 nights in 2011, and 161 nights in 2012. The log of observatories is given in table 1, where (1) the first column is the abbreviation of observer, (2) names of observer or observatory, (3) instrument used, and (4) comparison stars used. The journal of observations is summarized in table 4 (given Appendix in the Electric version). The chart of ER UMa and its comparison stars is presented in figure 1.

After dark-subtracting and flat-fielding in CCD observations, we performed aperture photometry of the variable and its comparison stars and obtained differential magnitudes. All observed times were transformed to barycentric Julian Days (BJD). We made corrections for the systematic differences between observers after that.

3. Result

In this section, we first present the results of our observations and their analysis then discuss their implications. We describe first the outburst behaviors of ER UMa in subsection 3.1, and we then discuss the negative superhumps and the positive superhumps in subsection 3.2, and 3.3, respectively, and we finally deal with the transition from negative superhump to positive superhump in subsection 3.4.

3.1. Outburst Light Curves

3.1.1. The overall light curves of ER UMa in 2011 and 2012

The overall light curve of ER UMa is presented in figures 2 for 2011 and 3 for 2012. The entire list of observed superoutbursts is shown in table 2, where (1) the first column is the identification of the superoutburst, (2) its starting date in BJD, (3) The date of BJD of the supermaximum, and (4) the length of supercycle, where the supercycle is defined from the starting date of the previous superoutburst to that of the current one. As seen in the figure 2 and 3, three superoutbursts in 2011 (2011 S1-S3) and three superoutbursts in 2012 (2012 S1-S3) were clearly observed during this observational campaign although a possible superoutburst candidate was also observed in 2012 (2012 S4) but it was unclear because of sparse data points. The length of observed of supercycles were in a range of 44–58 d. These
Fig. 2. Entire light curve of ER UMa of the 2011 season. The observed data is binned to 0.01 d.
Fig. 3. Entire light curve of ER UMa of the 2012 season. The observed data is binned to 0.01 d.
Table 1. Log of observatories

| The key to Observer | Observer or Observatory Name | Instrument | Comp |
|---------------------|-----------------------------|------------|------|
| KU                  | Kyoto University            | 40cmSCT+ST−9E | 1   |
| Aka                 | Akazawa Hidehiko            | 28cmSC,35.5cmSC | 1,4,5 |
|                     |                             | + ST-7XE, ST-9XE |      |
| AKz                 | Astrokolkhoz team*          | 30cmSC+ST−9,35cmSC+ST−8 | 2   |
| APO                 | Apache Point Observatory    | 50cmC+SITe   | 6   |
| BBo                 | Boyd Boitnott               | 28cmSC+QSI−516wsg | 6   |
| CRI                 | Crimean Astrophy. Obs.      | 60cm+Apogee Alta E47 | 6   |
| deM                 | Enrique de Miguel           | 28cmSC+QSI−516wsg / 25cmL | 2   |
| DPV                 | Pavol A. Dubovsky           | 28cmL+DSI ProH | 6   |
| Ham                 | Frantz–Josch Hambsch        | 40cm+STL11   | 2   |
| Ioh                 | Itoh Hiroshi                | 30cmSC+DSI-Pro | 6   |
| IMi                 | Ian Miller                  | 35cmSC+SXVR-H16 | 1,11 |
| Kai                 | Kasai Kiyoshi               | 28cmSC+ST−7XME | 1,4 |
| Kra                 | Tom Krajci                  | 28cmSC+SBIG ST-8 | 6   |
| LCO                 | Colin Littlefield           | 28cmSC+ST−8XME | 5,13,14 |
| Mhh                 | Hiroyuki Maehara            | 25cmL+ST−7XME | 4   |
| NDJ                 | Nick James                  | 28cmSC+SBIG ST-9XE | 2   |
| NKa                 | Natalia Katysheva           | 50cmR, 14cmC+ST-10XME | 1,2,4,6, |
|                     |                             |             | 8,9,10,12 |
| OKU                 | Osaka Kyoiku Univ.          | 51cm+ST−10 | 1 |
| OUS                 | Okayama Univ. of Sci. team  | 23.5cmSC+ST−8 | 6   |
| PSD                 | Stefano Padovan             | 25cm epsilon+ST-10XME | 1,3,8, |
|                     |                             |             | 10,13,15 |
| Pol                 | Polaris Observatory         | ST−7E       | 4   |
| Rui                 | Jevier Ruiz                 | 0.4mRC+ST−8XME | 1   |
| Sac                 | Seikei High School          | 15.2cmR+ST−9E | 5   |
| Shu                 | Sergey Shugarov             | 50cmR, 14cmC+ST-10XME | 1,2,4,6, |
|                     |                             |             | 8,9,10,12 |
| Siz                 | Siokawa Kazuhiko            | 35SC+ST-9E | 4   |
| SAO                 | Special Astrophysical       | 1m+EEV CCD42-40† | 1,2,4,6, |
|                     | Observatory†                |             | 8,9,10,12 |
| SWI                 | William Stein               | C14+SBIG ST-10XME | 2 |
| Ter                 | Terskol Observatory         | C14+STL1001 | 6   |
| Vir                 | Jani Virtanen               | C14+SBIG ST-10XME | 6 |
| VIR                 | Natalia Virnina             | 60cm       | 6   |
| Vol                 | Irina Voloshina             | 60cmL+Apogee 47 | 11  |

1: GSC 3439.629, 2: GSC3439.920 3: GSC3439.1287 4: TYC2-3439.1099.1 5: TYC3439.1253.1
6: GSC3439.669 7: GSC3439.816 8: GSC3439.957
9: GSC3439.1211 10: GSC3439.745 11: USNO1350.07816004
12: GSC3439.1105 13: GSC3439.911 14: TYC2-3439.916.1
15:GSC3439.1091 16: GSC3439.885
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†by Natalia Katysheva

values are in agreement with the previous report (Zemko et al. 2013). Table 3 shows the list of normal outbursts. The first column is the identification of a normal outburst. Here 2012 N2-3, for instance, indicates the third normal outburst in supercycle No.2 in 2012. We see from table 3 that the maximum magnitude of normal outburst gets brighter and the length of normal outburst cycles gets longer as the object approaches the next superoutburst (i.e. with an advance of supercycle phase), although there exists some exceptions (e.g. the interval between 2012 N1-2 and 2012 N1-3 is longer than that between 2012 N1-3 and 2012 N1-4).

3.1.2. Description of individual supercycles

Let us now examine the outburst behavior of individual supercycles. Here we define the identification of a supercycle by that of the starting superoutburst in a supercycle, that is, “supercycle 2011 S1”, for instance, is a supercycle which begins with a superoutburst 2011 S1, and ends with 2011 S2. The duration of a superoutburst is defined as a period
Table 2. List of superoutbursts

| ID   | The starting date of superoutburst (BJD-2400000) | The maximum date of superoutburst (BJD-2400000) | The maximum magnitude | The length of supercycle (d) |
|------|-----------------------------------------------|-----------------------------------------------|-----------------------|-----------------------------|
| 2011 S1 | 55578.8* | - | 12.6* | - |
| 2011 S2 | 55622.0 | 55625.1 | 12.7 | 44 |
| 2011 S3 | 55671.9 | 55674.4 | 12.7 | 50 |
| 2012 S1 | 55927§ | 55929§ | 12.9 | 58† |
| 2012 S2 | 55981.3 | 55982.6 | 13.0 | 54 |
| 2012 S3 | 56033.8 | 56034.4 | 12.9 | 53 |
| 2012 S4 | - | 56088.9† | - | 55 |

*Based on VSNET data
§The precise timing is unclear because of the scarcity of observations
†The date of previous superoutburst is based on VSNET data.
‡The estimated time of maximum, not the start of the outburst (due to the scarcity of observations)

from the time of maximum of the superoutburst to its end because the observations of rising stage were lacking in some cases.

Supercycle 2011 S1:
The superoutburst 2011 S1 was the first superoutburst when negative superhumps were first detected (Paper I). Time resolved observations started three days after the detection of the superoutburst. Unfortunately the rising part of this superoutburst was not observed and the existence of the positive superhumps in this superoutburst was not confirmed. However, we suspect that the positive superhumps must have appeared most likely in the earliest phase of this superoutburst. The superoutburst lasted for probably 13–15 d. Two days after the end of the superoutburst, the next normal outburst (2011 N1-1) started. In this supercycle, this object showed four normal outbursts (BJD 2455592, 2455597, 2455604, and 2455615). Besides them, a mini-outburst with the amplitude of only 1 mag occurred (BJD 2455611). The length of the supercycle was 44 d.

Supercycle 2011 S2 and 2011 S3:
The superoutburst 2012 S2 started as a form of a normal outburst and the start of the outburst was BJD 2455622 and persisted for 16 d. On BJD 2455642, 14 d after the supermaximum, the declining of the brightness temporarily ceased and this object brightened by 0.5 mag. The superoutburst 2011 S3 is similar to 2012 S2.

Supercycle 2012 S0:
Three normal outbursts (BJD 2455900, 2455909, 2455919) were caught before the first superoutburst where the time resolved observations were performed in the 2012 season. According to monitoring observation reported to VSNET, the previous superoutburst (2012 S0) occurred around BJD 2455869.

Supercycle 2012 S1:
Because of the lack of observations, it is unclear when the superoutburst 2012 S1 decayed although the decline occurred between BJD 2455941 and 2455943. Considering the maximum of the superoutburst was around BJD 2455962, the duration of superoutburst was approximately 15 d.

Supercycle 2012 S2:
The superoutburst 2012 S2 is an interesting case since the superoutburst was triggered on the way of decaying of normal outburst (the upper diagram of figure 4). The duration of the superoutburst 2012 S2 was 14 d. After the superoutburst ended, this object showed four normal outbursts (BJD 2456051, 2456057, 2456063, 2456070, 2456081) occurred.

Supercycle 2012 S3:
The superoutburst 2012 S3 is a typical superoutburst, which has a “shoulder” at the beginning of the superoutburst (the lower diagram of figure 4), which was shown in Osaki, Kato (2013a). Despite of the lack of the time-resolved observations in the late stage of the superoutburst 2012 S3, the VSNET data shows that this object declined around BJD 2456048–2456049. Thus the duration of the superoutburst 2012 S3 was 14–15 d. After the superoutburst decayed, four or five normal outbursts (BJD 2456051, 2456057, 2456063, 2456070, and 2456081) are detected. However, the fifth normal outburst (BJD 2456081) may be a precursor outburst of the next superoutburst 2012 S4. However, at any rate, the definite property of these outbursts are not clear because of the lack of the observations. The property of next outburst (2012 S4) is also unclear for the same reason.
### Table 3. List of normal outbursts

| ID      | Cycle length (d) | The starting date of outburst (BJD−2400000) | Maximum Magnitude |
|---------|------------------|--------------------------------------------|-------------------|
| 2011 N1-1 | -                | 55592.2                                   | 13.6              |
| 2011 N1-2 | 5.7              | 55597.9                                   | 13.5              |
| 2011 N1-3 | 6.6              | 55604.5                                   | 13.4              |
| 2011 N1-4 | 6.6              | 55611.1                                   | 14.3              |
| 2011 N1-5 | 4.0              | 55615.1                                   | 13.3              |
| 2011 N2-1 | -                | 55644.7                                   | 13.6              |
| 2011 N2-2 | 5.5              | 55650.2                                   | 13.4              |
| 2011 N2-3 | 6.7              | 55656.9                                   | 13.5              |
| 2011 N2-4 | 7.2              | 55664.1                                   | 13.2              |
| 2011 N3-1 | -                | 55693.3                                   | 13.7              |
| 2011 N3-2 | 4.8              | 55698.1                                   | 13.6              |
| 2011 N3-3 | 7.4              | 55705.5                                   | 13.6§              |
| 2011 N3-4 | 6.8              | 55712.3                                   | 13.4              |
| 2011 N3-5† | 9.0§             | 55721.3                                   | 13.2§              |
| 2012 N0-1 | -                | 55900.5                                   | 13.6              |
| 2012 N0-2 | 9.0              | 55909.5                                   | 13.5              |
| 2012 N0-3 | 9.5              | 55919.0                                   | 13.4              |
| 2012 N1-1 | -                | 55946.3                                   | 13.9              |
| 2012 N1-2 | 5.9              | 55952.2                                   | 13.7              |
| 2012 N1-3 | 8.9              | 55961.1                                   | 13.8              |
| 2012 N1-4 | 8.0              | 55969.1                                   | 13.5              |
| 2012 N2-1 | -                | 55998.8                                   | 13.5              |
| 2012 N2-2 | 5.9              | 56004.7                                   | 13.9              |
| 2012 N2-3 | 8.2              | 56012.9                                   | 13.9              |
| 2012 N2-4 | 9.3              | 56022.2                                   | 13.5              |
| 2012 N2-5 | 9.4              | 56031.6†                                   | 13.5              |
| 2012 N3-1 | -                | 56051.0*                                   | 13.7              |
| 2012 N3-2 | 6.4              | 56057.4*                                   | 13.8              |
| 2012 N3-3 | 6.5              | 56063.9*                                   | 13.7              |
| 2012 N3-4 | 6.7              | 56070.6*                                   | 13.7              |
| 2012 N3-5 | 11.3             | 56081.9*                                   | 14.2              |

‡The cycle length from the previous outburst to the current one
§The estimated maximum time, not the start of the outburst (due to the scarcity of observations)
†Precursor outburst of the next superoutburst
‡Suspected superoutburst
§Not so confirmed

### 3.2. The Frequency of Normal Outbursts

The number of normal outbursts in a supercycle in 2011 and 2012 was found to be mostly four and sometimes five (Table 1). The cases of five are exceptional and they will be discussed below. We reported in Paper I that the frequency of normal outbursts in the first supercycle of 2011 (i.e., 2011 S1) was lower than those found in previous observations of ER UMa and we suggested that the existence of negative superhumps (and so the existence of a tilted disk) might suppress frequent occurrence of normal outbursts. Zemko et al. (2013) pointed out that the number of normal outbursts in a supercycle of ER UMa varied between 4 and 6 for a long time scale and they also suggested that these differences are related to the appearance of the negative superhumps. As discussed in the next subsection, it has turned out that all supercycles of ER UMa observed in 2011 and 2012 were accompanied by the negative superhump and thus they were the type L-supercycles (see, (Osaki, Kato 2013a), for the definition of the type L- and type S-supercycles).

This trend did not change largely between two seasons. Although five normal outbursts were observed between 2012 S1 and S2, the superoutburst 2012 S2 occurred at the declining stage of the fifth normal outburst. Thus this normal outburst was a precursor of the next superoutburst. Another exception is 2011 N1-4, which will be discussed in the later subsection. Except for these cases, four normal outbursts were observed during one supercycle. The same
correlation between the appearance of negative superhumps and the frequency of normal outburst in a supercycle was known in other SU UMa stars, V503 Cyg (Kato et al. 2002, Pavlenko et al. 2012) and V1504 Cyg (Osaki, Kato 2013a). In this respect, Two exceptional cases of five normal outbursts in a supercycle are discussed here. As already mentioned in the individual supercycles, five normal outbursts occurred in supercycle 2012 S1 but the fifth one has turned out to be a precursor normal outburst of superoutburst 2012 S2 and it may be regarded as a part of the next superoutburst. Another exception is 2011 N1-4 and it was found to be a mini-outburst and it will be discussed in the later subsection.

3.2.1. Light Curve Profile and Rising Rate of Normal Outbursts in a Supercycle

Figure 5 illustrates variation in light curve profile of normal outbursts within supercycles. Figure exhibits the rising rates of normal outbursts within each supercycle. In the case of supercycle 2011 S1 (the left top panel of figure 5), we see that the rising rate to the maximum was getting slower with advance of supercycle phase except for the fifth one. We find from figure 5 that, generally speaking, the rising rate of the first normal outburst within each supercycle was faster than those is the light curves during of later ones. Two types of profiles in outburst light-curves are known to exist. The first one is that its rising rate is faster than its declining rate (i.e., rapid rise and slow decline) and the other one is that the rising rate to the maximum is not so fast but more or less similar to the decline rate (i.e., the light curve profile is more or less symmetric with respect to the rise and fall). In the disk instability model for the outburst of dwarf novae, the former type of light curve is produced by the “outside-in” type outburst (or the type A outburst in Smak (1984)) in which the transition to the hot state starts from the outer-part of the accretion disk and the heating front propagates inward while the latter type of outburst is produced by the “inside-out” outburst (type B in Smak (1984)) in which the transition to the hot state starts from the inner-part of the accretion disk. We find from these two figures that the first normal outburst in a supercycle looks like an “outside-in”-type, while most of other outbursts do like “inside-out”-type.

3.3. Negative superhumps

As shown in Paper I, negative superhumps are detected in ER UMa during superoutburst as well as during normal outbursts and quiescence. The negative superhumps were clearly detected except for the early stage of the superoutburst. Their amplitude is 0.5–1.0 mag in quiescence. We also show the amplitude variation in flux unit in figures 7, 8. In these diagram, 1 magnitude variation in 16 mag is normalized as 1. No dramatic change was associated with the change between quiescence and outburst is seen in flux unit (figures 7, 8) as already pointed in Osaki, Kato (2013a).

The valid interpretation for negative superhumps is the tilted accretion disk. The tilted disk show the retrograde precession, and Larwood (1998) presented a equation of $q$ and $\epsilon$ for a retrograde precession of the tilted disk. According to Larwood (1998), the frequency of negative superhump frequency is given by
Fig. 5. Rising stage of normal outbursts. In the cycle of 2012 N0, the maximum of normal outbursts is set at zero, and in other cycles the start of normal outbursts is set at zero.
Fig. 6. Rising speed variation of each supercycle. Since the rising speed can be estimated because of the unclear timing of the start of outburst in some of normal outbursts, they are omitted.
A good opportunity to investigate the variation of the disk radius through the variation of negative superhump period. Now we can observe the persistent negative superhump of ER UMa. Thus we have estimated the frequency of negative superhumps varies systematically during supercycles and the variation of the frequency is a good probe of the variation of the disk. For more details, see Appendix in Osaki, Kato (2013b).

\[ \epsilon_{-} = \frac{\nu_{\text{orb}} - \nu_{\text{nSH}}}{\nu_{\text{orb}}} = \frac{3}{7} \frac{q}{\sqrt{1 + q}} \left( \frac{R_d}{A} \right)^{3/2} \cos \theta \]

where \( \nu_{\text{orb}} \) and \( \nu_{\text{nSH}} \) are the frequency for negative superhumps and the orbital frequency of the binary, and \( \theta \) is the tile angle of the disk to the binary orbital plane. If \( \theta \) is small, we can assume \( \cos \theta \sim 1 \) and \( \nu_{\text{nSH}} \) can be determined by the disk radius \( R_d \) for specific system because \( q \) and \( A \) do not change in observational time-scale. In a real disk, \( \epsilon_{-} \) represents the precession of the disk as a whole, to which precession rates from different radii contribute. Since the precession rates in smaller radii is smaller, the actual \( \epsilon_{-} \) is smaller than what is expected for a ring in the outer radius of the disk. For more details, see Appendix in Osaki, Kato (2013b).

Indeed Osaki, Kato (2013b) indicated that the frequency of negative superhump is useful probe to study the change of the radius of accretion disks in SU UMa-type dwarf novae through the analysis of V1504 Cyg. In this case, the frequency of negative superhumps varies systematically during supercycles and the variation of the frequency is a good probe of the variation of the disk. Now we can observe the persistent negative superhump of ER UMa. Thus we have a good opportunity to investigate the variation of the disk radius through the variation of negative superhump period.

We analyzed the period of negative superhumps in two methods. In subsubsection 3.3.1, we will take the periodic analysis with a traditional method in the research of dwarf novae, drawing \( O - C \) diagrams. And in subsubsection 3.3.2, we will adopt a new method called least absolute shrinkage and selection operator (Lasso, Tibshirani 1996) and perform two dimensional spectral analysis.

3.3.1. \( O - C \) analysis

We estimated the maximum timings of negative superhumps in the way given in Kato et al. (2009) for data except for superoutburst stage. The template for fitting the maximum was an average profile of negative superhump from data in quiescence between 2011 S1 and S2 (The period of used data for template are BJD 2455595–2455598, BJD 2455602–2455604.5, BJD 2455608–2455611, BJD 2455618–2455621, and these data is folded by the mean negative superhump period of these data, 0.0623106 d). We also estimated the amplitude of negative superhumps and showed in the same figure.

The resultant \( O - C \) diagrams are figures 7, figure 8. The \( O - C \) diagrams indicate that the period of negative superhump period gradually shortens as the next superoutburst approaches. Namely the derivative of negative superhump period \( \dot{P}_{\text{nSH}} \) is negative between the successive superoutburst. The value of \( \dot{P}_{\text{nSH}} \) in 2011 is \(-1.10(6) \times 10^{-5} \) (supercycle 2011 S1), \(-1.32(4) \times 10^{-5} \) (supercycle 2011 S2), \(-1.04(11) \times 10^{-5} \) (supercycle 2011 S3). Meanwhile the value of \( \dot{P}_{\text{nSH}} \) in 2012 is \(-5(2) \times 10^{-6} \) (supercycle 2012 S0), \(-9.7(4) \times 10^{-6} \) (supercycle 2012 S1), \(-7.7(6) \times 10^{-6} \)
Fig. 8. $O-C$ diagram of negative superhumps, and related diagrams of each supercycle of 2012. The panel of (a), (b), (c) correspond to supercycle 2012 S0, 2012 S1, and 2012 S2. For each panel, top to bottom: (1) $O-C$ diagram of negative superhumps, (2) The amplitude of negative superhumps in flux, (3) The period of negative superhumps estimated by PDM analysis, (4) The light curve. The $O-C$ value is against the equation of $2445590.680 + 0.06223E$. The upper right panel shows diagrams during supercycle 2012 S0. The $O-C$ value is against the equation of $2445594.576 + 0.0623E$. The lower panel shows diagrams between 2012 S1 and 2012 S2. The value is against the equation of $2445597.123 + 0.0624E$.

(supercycle 2012 S2). The absolute value of $\dot{P}_{\text{SH}}$ in 2011 is larger than that in 2012. However, the figure of $O-C$ diagram shown in figure 8 includes more complicated structures with shorter time-scales, or from the view of normal outburst cycle. Namely, these $O-C$ curves are composed of multiple curves of concave-up shape although the general appearance was concave down in long time-scale, namely from the view of supercycle. The third panel of figures 7, 8 is denoted to the change of period during each supercycle. These values were calculated by PDM analysis for a 5-d interval. Since the width is near the interval of normal outburst, it is hard to detect clear change of the period when interval of two normal outburst is short.

Since the period of the negative superhump is shorter than the orbital period, small period of negative superhumps corresponds to the large negative fractional superhump deficit $\epsilon_-$. Thus this result implies that the absolute value of $\epsilon_-$ gradually increases as the next superoutburst approaches, and in shorter time-scale, the value of $\epsilon_-$ abruptly increases at the start of each normal outburst and gradually decreases until the next outburst starts. The increase of $\epsilon_-$ in the longer time-scale is because that the abrupt increase in the rising stage is larger than the gradual decrease in quiescence.

3.3.2. Lasso Period Analysis

Negative superhumps of ER UMa existed almost always during observations of 2011 and 2012. We made a detailed analysis for the frequency variations of negative superhumps. We computed two-dimensional power spectra of the light curve of ER UMa. We used locally weighted polynomial regression (LOWESS: Cleveland 1979) to the observation data in order to remove trends resulting from outbursts with R software\(^2\). After that, we estimated the pulsed flux by multiplying the residual amplitudes and LOWESS-smoothed light curve converted to the flux scale. We used 10 d with of the moving window, and 1 d as the time step because the data is not as contiguous as Kepler data. Since the window length is longer than the normal outburst cycle, the periodic change of shorter time-scale is not well resolved. However, the periodic variation of longer time-scale is clearly seen.

We performed a period analysis called least absolute shrinkage and selection operator (Lasso, Tibshirani 1996), which was introduced to analysis of astronomical time-series data (Kato, Uemura 2012, Kato, Osaki 2013b). This method is very suitable to find peaks in power spectra and very strong method to analysis the rapid change of the period as in outbursting dwarf novae, because Lasso analysis has the advantage that peaks in power spectra are very sharp, and that it is less affected by uneven sampling data than Fourier analysis.

The resultant two-dimensional power spectra are shown in figures 9, 10. These figures show that the clear signal of

\(^2\) http://www.r-project.org/index.html
Fig. 9. Two dimensional period analysis of ER UMa using Lasso in 2011 season. For each two panels, the upper panel is the light curve and the lower panel is the power spectrum. The width of the window is 10 d, and the time step is 1 d.
Fig. 10. Two dimensional period analysis of ER UMa using Lasso in 2012 season. For each two panels, the upper panel is the light curve and the lower panel is the power spectrum. The width of the window is 10 d, and the time step is 1 d.
negative superhump signal was always detected during two seasons, except for the early stage of superoutburst and later phase of 2011 season. Positive superhump signal was detected only in the early stage of superoutburst. The frequency of negative superhump changes during the supercycle. The frequency of negative superhump was smallest when the superoutburst ended and increases toward the next superoutburst.

Interestingly the Lasso diagram, especially in 2012 show orbital modulation is detected. Although we tried to the period of orbital modulation, significant signal is not seen because the signal was seen only partly.

Kato et al. (2013) and Osaki, Kato (2014) showed that the variation of negative superhump period in BK Lyn and ER UMa is not so large as that of ordinary SU UMa-type, such as V344 Lyr and V1504 Cyg and suggested this is because of the interval of these objects is extremely short.

### 3.3.3. The Discussion about the Periodic Variation in Negative Superhumps

Both the $O-C$ diagram and the Lasso analysis show that the negative superhump period shortens as the next superoutburst approaches in long time-scale. However, in short time-scale, the period of negative superhumps tends to became longer in quiescence and an abrupt shortening occurs at the start of normal outbursts. By the combination of these two effects, the period of negative superhump period becomes shorter as a whole accompanied by smaller variations coinciding with normal outbursts outside the superoutburst stage. This change corresponds to the global form of the $O-C$ diagram. The period change estimated by the PDM analysis is also in good agreement with this result.

The theoretical relation implies that the increase of $\nu_{nSH}$ can be interpreted as the increase of $R_d/A$. Thus the change of negative superhump period can be interpreted that the radius of the disk increases when the normal outburst is triggered and the accretion disk shrinks until the next normal outburst starts although the increase is larger than the decrease. This change of disk radius is similar that of V1504 Cyg shown in (Osaki, Kato 2013b). The TTI model suggests that the increase of disk radius at the start of outburst because of the conservation of angular momentum and the increased viscosity (Osaki 1989). After the outburst has finished, the disk radius shrinks until the next outburst starts. The negative superhump period becomes shorter as the next superoutburst approaches. Our result obeys this trend.

### 3.4. Positive superhump

#### 3.4.1. The Stage A Superhumps

ER UMa also shows positive superhumps. In recent researches (e.g. Kato et al. 2009), a superoutburst can divided to three stages named stage A, B, and C from the change of superhump period. Stage A corresponds to the evolving phase of superhump, when the tidal instability is limited within 3:1 resonance radius. After the superhumps after stage B, the eccentric wave spread to inner region of the disk and the pressure effect appears (Osaki, Kato 2013b). Thus stage A superhump period gives us the mass ratio $q$ of the system (Kato, Osaki 2013a). It is very useful to detect stage A superhump and estimate the period.

Kato, Osaki (2013a) suggested an explanation why stage A superhumps are difficult to detect in ER UMa-type dwarf novae. In ER UMa-type dwarf novae, the superoutburst is not necessarily triggered by a normal outburst but

![Fig. 11. Stage A superhump of 2011 S2. LOWESS fitting and the subtraction of negative superhump signal is already taken. The observed data is binned to 0.001 d.](image-url)
by the eccentric instability [called Case C outburst Osaki, Meyer (2003)]. In such case, the pressure effect has already been strong at the start of a superoutburst and the method to estimate \( q \) with stage A superhump period may not be applicable. However, in superoutbursts during our observations, positive superhumps were triggered by normal outburst as well as other usual SU UMa-type objects. Therefore the existence of the stage A superhump is expected.

As seen in figures 9 and 10, negative and positive superhumps co-exist during the superoutburst. It is supposed that positive superhump is caused by prograde precession of the elliptical disk and negative superhumps are caused by retrograde precession of the tilted disk. The co-existence of positive superhump and negative superhump suggests that the disk is eccentric and tilted at the same time.

This co-existence of negative and positive superhumps is a problem to estimate the maximum timings of positive superhumps. We have to subtract the variations of negative superhumps. We adopted the averaged light curve of negative superhump used for the subtraction. First we subtracted from the original light curve translated to the flux scale. After that, the averaged light curve was formed data subset during one beat cycle. With this averaged light curve, After the subtraction, the scale was translated to the magnitude scale again. The subtracted light curve is figure 11.

After subtraction of negative superhumps, The \( O-C \) diagrams of five superoutbursts are figures 12, 13. In 2011 S1, negative superhump was dominant at the start of time-resolved observation, thus \( O-C \) curve of positive superhump could not be drawn.

Among five superoutbursts, stage A superhumps were detected in three superoutbursts (2011 S2, 2012 S2, and 2012 S3). These detection were based on the longer superhump period and the increase of the amplitude of superhumps in the earliest stage of the superoutburst. For instance, the amplitude of the positive superhumps evolved to 0.25 mag until \( E = 10 \) in 2011 S2 (figure 11). In 2011 S3 and 2012 S1, it was difficult to estimate stage A superhump period because of the lack of observation. After the amplitude of the positive superhumps reached the maximum, the amplitude of positive superhump became gradually smaller. These can be regarded as stage B superhumps. The perfect subtraction of negative superhump, especially in the later stage, is difficult, however. The profile of superhumps of ER UMa during superoutburst does no seem to be simple superposition of positive and negative superhumps.

We then obtained the periods of stage A superhumps. For the data of 2011 S2, A PDM analysis yielded a stage A superhump period of 0.06604(9) \( \text{d} \). Similarly the stage A superhump period is estimated as 0.06570(2) \( \text{d} \) in 2012S2 and 0.06624(4) \( \text{d} \) in 2012 S3. With this data, the estimated \( q \) is 0.100(6) by the method of Kato, Osaki (2013a). Data of other superoutbursts show somewhat different value, 0.088 (2012 S2) and 0.114 (2012 S3). Using an average of these values, we adopted \( q \) of ER UMa to be 0.100(15).
Fig. 13. $O-C$ diagrams of positive superhumps after subtracting negative superhumps of 2012 S1 – S3. The value is against the equation of $2455924.094 + 0.065619 \times E$ (for 2012 S1), $2455982.403 + 0.065619 \times E$ (for 2012 S2), $2456034.104 + 0.065710 \times E$ (for 2012 S3).
3.4.2. System Property and Evolutionary State

The estimated value of $q$, 0.100(15), suggests that ER UMa is on the standard evolutionary track in Knigge et al. (2011) since the orbital period is 0.06366 d. Our results indicate that there is no evidence that ER UMa is in the evolutionary stage different from ordinary CVs although $\dot{M}$ of ER UMa is much higher than other SU UMa-type dwarf novae with similar orbital periods.

Hellier (2001b) suggested that the unusual behavior of ER UMa-type (rapid recurrence of normal outbursts) or WZ Sge-type objects (rebrightenings) may be explained if these objects have extremely low $q$ (i.e. near the period minimum or period bouncers) and the thermal and tidal instabilities are decoupled due to the weak tidal force. Our present result indicates that at least ER UMa itself is not the case. We consider that there is no necessity to consider decoupling of the thermal and tidal instabilities for ER UMa as shown by Osaki (1995a), in which the behavior of ER UMa can be reproduced by increasing the $\dot{M}$, while there remains a possibility for RZ LMi (Osaki 1995b). Determination of the orbital period and detection of stage A superhumps for RZ LMi and DI UMa are desired to solve this problem.

3.4.3. The relation between Positive and Negative Superhumps

The left panel of figure 15 shows the relation between the negative superhump period and the positive superhump period for systems which show both superhumps. Theoretically, the ratio the negative superhump period to the positive superhump period is 4/7 when the pressure effect do not effect. Most of that of systems obeys this relation. Among systems deviating from the theoretical relation, KIC 8751494 can be explained by the pressure effect Kato, Maehara (2013). The negative superhump of V1159 Ori may be not true negative superhumps, but “impulsive negative superhumps” (Osaki, Kato 2013b) 3.

Our value of ER UMa is especially consistent with this relation. Although Gao et al. (1999) is far shorter than our value and theoretical prediction, this may also be an “impulsive negative superhump”. The right panel of figure 15 shows the relation between the orbital period and the negative superhump deficit.

3.5. The Transition from Negative Superhump to Positive Superhump

In paper I, we reported that the the maximum timings of negative and positive superhumps developed continuously and there was no phase shift between them. Paper I suggested that it implies the source of negative and positive superhumps is the same. The similar trend was seen also in other rising stages. However, this is unclear because the amplitude of superhumps in transition stage was small. We tested this suggestion in model calculations.

3.5.1. The transition from the negative to the positive superhump

The right panel of figure 15 shows the relation between the negative and positive superhumps. The transition is not sharp, but gradual. The distributions of the transition points are similar to that of the negative superhumps in the left panel. The theoretical relation, KIC 8751494 can be explained by the pressure effect Kato, Maehara (2013). The negative superhump of V1159 Ori may be not true negative superhumps, but “impulsive negative superhumps” (Osaki, Kato 2013b) 3.

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Fig. 15. $\epsilon_+ \ vs. \ \epsilon_-$ diagram. The solid line implies that the theoretical predicted relation in the absence of the pressure effect. Reference: V1159 Ori (Patterson et al. 1995), AM CVn (Skillman et al. 1999, Patterson 1998, Patterson 1999), PX And (Stanishev et al. 2002), TV Col (Retter et al. 2003), BF Ara (Kato et al. 2003, Olech et al. 2007), V1405 Aql (Chou et al. 2001 Retter et al. 2002) AH Men (Patterson 1995), IR Gem (Fu et al. 2004), V503 Cyg (Harvey et al. 1995), TT Ari (Skillman et al. 1998, Andronov et al. 1999, Wu et al. 2002), V603 Aql (Patterson et al. 1997), RR Cha (Woudt, Warner 2002), V344 Lyr Still et al. 2010 (Osaki, Kato 2013b), V1504 Cyg (Osaki, Kato 2013b, Osaki, Kato 2013a), QU Aqr (Olech et al. 2009, Tramposch et al. 2005), BC Dor (Woudt et al. 2005), DW UMa (Stanishev et al. 2004, Patterson et al. 2005), V1974 Cyg (Olech 2002), KIC 8751494 (Kato, Maehara 2013), CSS 091121:033232+020439 (Woudt et al. 2012), KIC 7524178 (Kato, Osaki 2013b)

Fig. 16. Model calculation of the superimposition of negative and positive superhumps. In the left panel, the positive superhump starts at phase 0 when the phase of the negative superhump is also 0. In the right panel, the positive superhump starts at phase 0 when the phase of the negative superhump is 0.5. For each case, the variation of amplitude of hump and $O-C$ diagram at the transition stage from positive to negative superhump is shown.
Fig. 17. $O-C$ diagrams, amplitude variation, and the light curve (0.01 d-binned) during the rising stage of superoutbursts. The upperleft panel is the diagram of the superoutburst 2011S3. The values of $O-C$ diagram is against the equation of \(2455671.039 + 0.0622E\). The upperright panel is the diagram of the superoutburst 2012S1. The values of $O-C$ diagram is against the equation of \(2455923.646 + 0.0622E\). The bottomleft panel is the diagram of the superoutburst 2012S2. The values of $O-C$ diagram is against the equation of \(2456077.211 + 0.0622E\). The bottomright panel is the diagram of the superoutburst 2012S3. The values of $O-C$ diagram is against the equation of \(2456077.211 + 0.0622E\). For 2011S1, see fig 3 of Paper I. These diagrams suggests \(245630.052 + 0.0622E\).
We assumed the positive superhump develops in the rising stage of the superoutburst and the constant amplitude in flux of negative superhump, 0.7 mag in quiescence. The rising rate of mean magnitude is 2.1 mag / d. Positive superhumps to start the development four cycles after the rising starts. After positive superhumps appearing, the amplitude of positive develops at the speed of 0.15 mag /d. For the profile of negative and positive superhumps, the template profiles used for non-linear fitting were adopted.

The resultant diagrams are shown in figure 16. In the upper diagram, the phases of negative and positive superhump are continuous when the positive superhumps start to develop. In the lower diagram, the phases of negative and positive superhump are different by 0.5. The both diagrams both show the decrease of the amplitude of variation when the positive superhumps begin to develop. Furthermore, the negative superhump phase evolve into the positive superhump smoothly in the both O−C diagrams. In the upper panel of figure 16, O−C variation does not show small a smooth transition from negative superhump to positive superhump, but shows more complex structure. This is caused by the superimposition of the maxima of negative and positive superhump. However, since the amplitude of positive superhump is small, the shift of O−C value is small.

The O−C diagrams of the rising stage of each superoutburst is shown in figure 17. These O−C diagrams imply that the negative and positive superhumps are continuous without phase shift as in the lower case of figure 16. This result suggests that the position where the positive superhump is not randomly excited in relation to negative superhumps.

This result would not be expected if the negative superhumps arise from the varying release of the potential energy on a tilted disk and the phase of the tilt is random to the observer when positive superhumps start to grow. Either our understanding of the origin of negative superhumps may be insufficient or the statistics may not sufficient to prove whether the positive superhump is randomly excited in relation to negative superhumps. Further systematic observations of the rising stage of superoutbursts are required.

4. Conclusion

We observed the SU UMa-type dwarf nova ER UMa in the years 2011 and 2012 by VSNET worldwide campaign and we obtained data of 307 nights spanning in 2011 – 2012. We detected persistent negative superhumps during the superoutbursts as well as during normal outbursts and quiescence in both seasons. We analyzed these data and obtained the following are our major findings:

(1) We succeeded in covering three supercycles of this star in 2011 and also three supercycles in 2012. The star showed persisted superhumps in both seasons.

(2) We analyzed periodic variations of negative superhumps in a supercycle of this star by O−C analysis, PDM analysis, and Lasso analysis. We have found from these analyses that the period of negative superhumps between two successive superoutbursts decreases secularly from the end of a superoutburst to the next superoutburst in a longer time-scale of a supercycle. Superimposed on this long time-scale trend, a shorter time-scale variation in the negative superhump period occurred within a normal outburst cycle in a sense that the period was shortened when a normal outburst occurred and it became longer during quiescence. When the next supercycle started, the period of negative superhumps returned to the value when the previous supercycle started. Thus it varied cyclically with the same supercycle period as that of the light curve. This variation was indicates as a result of the variation in the disk radius and the disk radius was the smallest at the end of a superoutburst. The variation in the disk radius inferred by our analysis of ER UMa is in agreement with the predicted variation of the disk radius by the TTI theory.

(3) The rising rate of maximum of the normal outburst varied during one supercycle. The rising rate of the first normal outburst within a supercycle was found to be faster than the later ones. This suggests that the first normal outburst may most likely be of the “outside-in” type while the later ones may be of the “inside-out” type. The occurrence of the “inside-out”-type outbursts in ER UMa may be understood as due to the mass supply from the secondary to the inner part of the disk when the disk tilted.

(4) The negative superhumps and the positive superhumps co-existed during the superoutburst although the signal of the negative superhump was marginal in the first several days of the superoutburst. By subtracting the signal of negative superhumps, we obtained the O−C diagram for the positive superhumps and by doing so we were able to distinguish the stage A from the B ones. A simple combination of the positive and negative superhumps was not sufficient to reproduce the complex profile variation.

(5) The number of normal outbursts in a supercycle of ER UMa in 2011 and 2012 was found to be mostly four, which was smaller than that in other occasions when negative superhumps were not observed, a result consistent with those reported for ER UMa by Zemko et al. (2013) and for V1504 Cyg by Osaki, Kato (2013a). This can be understood as a result of the tilted disk: when the disk is tilted, the gas stream coming from the secondary arrives at the inner region of the disk rather than at the disk edge and this reduces a frequent occurrence of the outside-in type normal outbursts.

(6) Some of the superoutbursts were triggered by the normal outbursts (i.e. precursor outbursts). Positive superhumps started to grow during the declining part of the precursor in such superoutbursts. The phases of maxima were found to be continuous when a transition from the negative superhump to the positive superhump occurred.
(6) We succeeded in detecting stage A superhumps for the first time in ER UMa-type dwarf novae during the precursor parts of three superoutburst. Using the period of stage A superhumps, we estimated $q$ of ER UMa to be 0.100(15). The estimated $q$ and the known orbital period imply that ER UMa itself is in the standard evolutionary track of cataclysmic variable stars. However, the mass transfer late, $M$ of ER UMa, inferred from its short supercycle length and frequent occurrence of normal outbursts, is much higher than that of other SU UMa-type dwarf novae with similar orbital periods.

The authors are grateful to observers of VSNET Collaboration and VSOLJ observers, who contributed observations, covering long-term variations of ER UMa as long as two years.

This work was partly supported by the Grant-in-Aid “Initiative for High-Dimensional Data-Driven Science through Deepening of Sparse Modeling” from the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan, and Grants-in-Aid for the Global COE Programme “The Next Generation of Physics, Spun from Universality and Emergence” from the Ministry of Education, Culture, Sports, Science and Technology of Japan. We are very grateful to the referee of this paper, Osaki, Y.

Appendix 1. The list of all observations

Appendix 2. The maximum timings of negative superhumps

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### ER UMa observations

#### Table 4. Log of observation list

| Start  | End   | N  | obs | sys  | exp |
|--------|-------|----|-----|------|-----|
| 81.4612 | 81.7636 | 382 | deM | C    | 60s |
| 83.0675 | 83.3887 | 410 | Aka | C    | 60s |
| 83.9591 | 84.0433 | 100 | Kra | -    | 30s |
| 84.0048 | 84.0497 | 99  | Kra | C    | 30s |
| 84.0048 | 84.3783 | 888 | Ioh | C    | 15s |
| 84.6368 | 84.7775 | 306 | Kra | C    | 30s |
| 85.6340 | 86.0532 | 917 | Kra | C    | 30s |
| 86.0664 | 86.3767 | 421 | Aka | C    | 60s |
| 87.1712 | 87.3828 | 293 | Aka | C    | 60s |
| 87.7992 | 88.0526 | 549 | Kra | C    | 30s |
| 88.0493 | 88.3827 | 434 | Aka | C    | 60s |
| 88.7965 | 89.0512 | 401 | Kra | C    | 50s |
| 89.0715 | 89.3325 | 338 | Aka | C    | 60s |
| 89.7937 | 90.0516 | 406 | Kra | C    | 50s |
| 90.0890 | 90.3768 | 341 | Aka | C    | 60s |
| 90.1906 | 90.2003 | 15  | Ioh | C    | 15s |
| 90.2019 | 90.3130 | 437 | KU  | C    | 15s |
| 90.4132 | 90.7707 | 447 | deM | C    | 60s |
| 90.7909 | 91.0508 | 409 | Kra | C    | 50s |
| 90.9506 | 91.3721 | 1011 | Ioh | C    | 15s |
| 91.0508 | 91.3786 | 441 | Aka | C    | 60s/45s |
| 91.1379 | 91.3305 | 111 | OUS | C    | 60s |
| 91.1400 | 91.3355 | 161 | OUS | -    | 30s |
| 91.1908 | 91.3808 | 808 | KU  | C    | 15s |
| 91.5065 | 91.6415 | 232 | Ter | C    | 45s |
| 91.5456 | 91.7274 | 226 | deM | C    | 60s |
| 91.7882 | 92.0505 | 413 | Kra | C    | 50s |
| 92.0075 | 92.3762 | 823 | Ioh | C    | 15s |
| 92.0661 | 92.3867 | 554 | Aka | C    | 60s |
| 92.5366 | 92.7694 | 287 | deM | C    | 60s |
| 92.9491 | 93.3727 | 1030 | Ioh | C    | 15s |
| 93.3783 | 93.4599 | 208 | VIR | C    | 30s |
| 93.5361 | 93.7695 | 296 | deM | C    | 60s |
| 93.9749 | 94.3798 | 520 | Aka | C    | 60s |
| 94.0172 | 94.3707 | 893 | Ioh | C    | 15s |
| 94.1159 | 94.2477 | 360 | OKU | Rc   | 30s |
| 94.5085 | 94.7697 | 329 | deM | C    | 60s |
| 95.0433 | 95.3570 | 404 | Aka | C    | 60s |
| 95.1841 | 95.3707 | 477 | Ioh | C    | 15s |
| 95.2823 | 95.3603 | 120 | Mhh | Ic   | 50s |
| 95.2828 | 95.3606 | 99  | Mhh | V    | 60s |
| 95.5754 | 95.7112 | 161 | IMi | C    | 60s |
| 95.9480 | 96.3715 | 1000 | Ioh | C    | 15s |
| 95.9731 | 96.2966 | 444 | OUS | C    | 60s |
| 96.0769 | 96.3755 | 353 | Aka | C    | 60s |
| 96.3357 | 96.7662 | 551 | deM | C    | 60s |
| 96.7249 | 96.8251 | 125 | SWI | C    | 60s |
| 97.0216 | 97.3172 | 711 | Ioh | C    | 15s |
| 97.3349 | 97.5277 | 248 | deM | C    | 60s |
| 97.4345 | 97.7262 | 849 | Rui | C    | 60s/15s |
| 97.9645 | 98.2434 | 588 | Ioh | C    | 15s |

*BJD−2455500.*

| Number of observations. |
| Observer's code. |
| Filter. “C” means no filter (clear). |
Table 4. (Continued.)

| Start*  | End*   | \(N\)§ | obs∥ | sys# | exp   |
|--------|--------|--------|------|------|-------|
| 98.0075 | 98.3787 | 454    | Aka  | C    | 60s   |
| 98.0662 | 98.2102 | 197    | Mhh  | Ic   | 60s   |
| 98.1520 | 98.3217 | 129    | OKU  | V    | 30s   |
| 98.3438 | 98.7638 | 513    | deM  | C    | 40s/60s|
| 98.3771 | 98.3876 | 16     | Kai  | C    | 30s   |
| 98.7125 | 98.9376 | 277    | SWI  | C    | 60s   |
| 99.0687 | 99.2541 | 214    | Aka  | C    | 60s   |
| 99.1766 | 99.3704 | 501    | Ioh  | C    | 15s   |
| 99.3583 | 99.7604 | 661    | deM  | C    | 40s   |
| 100.0162| 100.1296| 166    | Ioh  | C    | 15s   |
| 100.0320| 100.3259| 357    | Aka  | C    | 60s   |
| 100.2493| 100.3382| 209    | OKU  | Re   | 30s   |
| 100.3676| 100.4750| 129    | deM  | C    | 60s   |
| 100.5620| 101.0463| 848    | Kra  | C    | 40s   |
| 101.2780| 101.6386| 414    | Ter  | C    | 60s   |
| 101.2909| 101.6901| 259    | Ham  | C    | 120s  |
| 101.5025| 101.6849| 157    | deM  | C    | 60s   |
| 101.9803| 102.1047| 299    | Siz  | C    | 20s   |
| 102.0555| 102.1884| 335    | Ioh  | C    | 15s   |
| 102.0806| 102.3758| 282    | Aka  | C    | 60s   |
| 102.5646| 103.0406| 794    | Kra  | C    | 40s   |
| 103.3178| 103.4895| 178    | deM  | C    | 60s   |
| 103.6117| 104.0452| 726    | Kra  | C    | 40s   |
| 104.3228| 104.5033| 228    | deM  | C    | 60s   |
| 104.5656| 105.0448| 830    | Kra  | C    | 40s   |
| 104.5751| 104.7502| 236    | deM  | C    | 60s   |
| 104.6818| 104.8553| 230    | SWI  | C    | 60s   |
| 105.0303| 105.3237| 738    | Ioh  | C    | 15s   |
| 105.0545| 105.3793| 444    | Aka  | C    | 60s   |
| 105.0618| 105.3481| 750    | Siz  | C    | 20s   |
| 105.6684| 105.8555| 248    | SWI  | C    | 60s   |
| 105.6728| 105.9557| 128    | Tze  | C    | 180s  |
| 105.7499| 106.0439| 460    | Kra  | C    | 50s   |
| 105.8879| 106.1951| 774    | Siz  | C    | 20s   |
| 105.9691| 106.1430| 500    | Ioh  | C    | 15s   |
| 106.1305| 106.1875| 140    | Mhh  | Ic   | 50s   |
| 106.0108| 106.1138| 140    | Mhh  | V    | 50s   |
| 106.4233| 106.7516| 585    | deM  | C    | 40s   |
| 106.7472| 106.9127| 209    | Kra  | C    | 60s   |
| 107.2270| 107.3805| 195    | CRI  | C    | 60s   |
| 107.6803| 107.8480| 220    | SWI  | C    | 60s   |
| 107.7444| 107.8746| 206    | Kra  | C    | 40s   |
| 107.8336| 108.1970| 841    | Siz  | C    | 20s   |
| 107.9666| 108.3491| 417    | Aka  | C    | 60s   |
| 108.0046| 108.1782| 442    | Ioh  | C    | 15s   |
| 108.3286| 108.5021| 217    | deM  | C    | 60s   |
| 108.6656| 108.8346| 222    | SWI  | C    | 60s   |
| 108.7416| 108.8744| 210    | Kra  | C    | 50s   |
| 108.9068| 109.1166| 194    | OKU  | C    | 30s   |
| 109.2959| 109.5950| 129    | Ham  | C    | 120s  |
| 109.6384| 109.8408| 263    | SWI  | C    | 60s   |

*BJD−2455500.

§Number of observations.

∥Observer’s code.

#Filter. “C” means no filter (clear).
| Start*  | End*   | N§  | obs∥ | sys# | exp  |
|--------|--------|-----|------|------|------|
| 109.7389  | 109.8747 | 182 | Kra  | C    | 60s  |
| 110.3096  | 110.4380 | 161 | deM  | C    | 60s  |
| 110.9516  | 111.3784 | 576 | Aka  | C    | 60s  |
| 111.1731  | 111.3261 | 383 | Ioh  | C    | 15s  |
| 111.6402  | 111.8384 | 259 | SWI  | C    | 60s  |
| 112.6350  | 112.8428 | 271 | SWI  | C    | 60s  |
| 112.9592  | 113.3599 | 383 | deM  | C    | 60s  |
| 113.3073  | 113.7121 | 624 | deM  | C    | 60s  |
| 113.8963  | 114.2047 | 804 | Siz  | C    | 20s  |
| 113.9407  | 114.3703 | 581 | Aka  | C    | 60s  |
| 114.0164  | 114.3544 | 883 | Ioh  | C    | 15s  |
| 114.3581  | 114.7079 | 231 | Ham  | C    | 120s |
| 114.3563  | 114.7528 | 434 | deM  | C    | 60s  |
| 114.5701  | 114.8325 | 412 | Kra  | C    | 50s  |
| 114.6531  | 114.8419 | 250 | SWI  | C    | 60s  |
| 114.9430  | 115.3067 | 368 | Aka  | C    | 60s  |
| 115.0414  | 115.2215 | 504 | OKU  | C    | 30s  |
| 115.1288  | 115.3592 | 464 | Ioh  | C    | 15s  |
| 115.3055  | 115.7433 | 449 | deM  | C    | 60s  |
| 115.4450  | 115.6201 | 113 | Ham  | C    | 120s |
| 115.6005  | 115.8361 | 312 | SWI  | C    | 60s  |
| 115.7667  | 115.9162 | 233 | Kra  | C    | 50s  |
| 116.0311  | 116.3476 | 307 | Aka  | C    | 60s  |
| 116.1918  | 116.5826 | 171 | CRI  | C    | 180s |
| 116.3069  | 116.7393 | 430 | deM  | C    | 60s  |
| 116.3363  | 116.4372 | 166 | Vir  | C    | 40s  |
| 116.6007  | 116.8355 | 303 | SWI  | C    | 60s  |
| 116.8205  | 116.9164 | 142 | Kra  | C    | 50s  |
| 117.1067  | 117.2920 | 497 | Ioh  | C    | 15s  |
| 117.3084  | 117.7357 | 438 | deM  | C    | 60s  |
| 117.6185  | 117.6844 | 46  | BBo  | C    | 120s |
| 117.6828  | 117.9781 | 371 | SWI  | C    | 60s  |
| 117.7611  | 117.9160 | 243 | Kra  | C    | 50s  |
| 118.0090  | 118.3736 | 491 | Aka  | C    | 60s  |
| 118.0174  | 118.3152 | 721 | Ioh  | C    | 15s  |
| 118.2117  | 118.3394 | 68  | CRI  | C    | 150s |
| 118.3091  | 118.7359 | 438 | deM  | C    | 60s  |
| 118.6750  | 118.9915 | 402 | SWI  | C    | 60s  |
| 118.9255  | 119.0919 | 404 | Ioh  | C    | 15s  |
| 119.3099  | 119.6462 | 299 | deM  | C    | 60s  |
| 119.6145  | 119.6816 | 46  | BBo  | C    | 120s |
| 120.2034  | 120.3633 | 581 | KU   | C    | 15s  |
| 120.3107  | 120.7317 | 394 | deM  | C    | 60s  |
| 120.6472  | 120.9834 | 430 | SWI  | C    | 60s  |
| 121.3146  | 121.7299 | 530 | deM  | C    | 60s  |
| 121.5807  | 121.6735 | 60  | BBo  | C    | 120s |
| 121.5997  | 121.8141 | 283 | SWI  | C    | 60s  |
| 121.7500  | 121.9161 | 257 | Kra  | C    | 50s  |
| 122.5434  | 122.6705 | 179 | DPV  | V    | 30s  |
| 122.6069  | 122.7674 | 100 | BBo  | C    | 120s |
| 122.7472  | 122.9159 | 267 | Kra  | C    | 50s  |

*BJD−2455500.
§Number of observations.
∥Observer’s code.
#Filter. “C” means no filter (clear).
| Start*  | End*  | \(N^\|\) | obs\(\|\) | sys\# | exp |
|---------|-------|----------|--------|-------|-----|
| 122.7740 | 122.9897 | 280 | SWI | C | 60s |
| 122.9399 | 123.3472 | 485 | Aka | C | 60s |
| 123.3837 | 123.5611 | 118 | CRI | C | 120s |
| 123.3886 | 123.4930 | 137 | DPV | V | 30s |
| 123.5855 | 123.8297 | 147 | BBBo | C | 120s |
| 123.6400 | 123.8103 | 225 | SWI | C | 60s |
| 123.7444 | 123.9162 | 269 | Kra | C | 50s |
| 123.9091 | 123.9275 | 21 | Sac | C | 60s |
| 123.9348 | 124.3598 | 436 | Aka | C | 60s |
| 124.0499 | 124.1438 | 138 | Mhh | Ic | 50s |
| 124.0502 | 124.1441 | 137 | Mhh | V | 50s |
| 124.0954 | 124.1545 | 171 | Ku | C | 15s |
| 124.2111 | 124.3360 | 182 | OUS | C | 50s |
| 124.2148 | 124.6109 | 937 | CRI | C | 30s |
| 124.2581 | 124.6708 | 1101 | DPV | C | 30s |
| 124.3066 | 124.4592 | 362 | Kai | C | 30s |
| 124.3613 | 124.7064 | 224 | Ham | C | 120s |
| 124.7416 | 124.9162 | 277 | Kra | C | 50s |
| 124.9840 | 125.1650 | 290 | OUS | C | 50s |
| 124.9999 | 125.3501 | 936 | Ioh | C | 15s |
| 125.0662 | 125.3525 | 396 | Aka | C | 60s |
| 125.1928 | 125.4915 | 709 | CRI | C | 30s |
| 125.2698 | 125.5950 | 210 | Ham | C | 120s |
| 125.2941 | 125.3311 | 96 | Kai | C | 30s |
| 125.5703 | 125.6805 | 70 | BBBo | C | 120s |
| 125.7389 | 125.8501 | 176 | Kra | C | 50s |
| 125.7667 | 125.9886 | 288 | SWI | C | 60s |
| 125.9322 | 126.2387 | 496 | Aka | C | 60s |
| 125.9501 | 126.3087 | 735 | Ioh | C | 15s |
| 125.9525 | 126.3509 | 1036 | Siz | C | 30s |
| 126.0425 | 126.1294 | 140 | Mhh | Ic | 45s |
| 126.0428 | 126.1297 | 140 | Mhh | V | 45s |
| 126.3339 | 126.5086 | 135 | Shu | V | 20s |
| 126.3343 | 126.5091 | 133 | Shu | R | 20s |
| 126.3351 | 126.4722 | 101 | Shu | B | 20s |
| 126.3568 | 126.5146 | 101 | Ham | C | 120s |
| 126.3832 | 126.4438 | 81 | CRI | C | 60s |
| 126.6707 | 126.7842 | 70 | BBBo | C | 120s |
| 126.9105 | 127.1181 | 504 | Ioh | C | 15s |
| 127.2797 | 127.7019 | 274 | Ham | C | 120s |
| 127.3103 | 127.7107 | 531 | deM | C | 40s/60s |
| 127.9194 | 128.3468 | 768 | Aka | C | 60s |
| 128.2648 | 128.6815 | 207 | Shu | B | 160s |
| 128.2652 | 128.6821 | 213 | Shu | V | 160s |
| 128.2656 | 128.6825 | 269 | Shu | R | 120s |
| 128.2683 | 128.4314 | 39 | Shu | U | 180s |
| 128.2702 | 128.6578 | 1009 | DPV | C | 30s |
| 128.2863 | 128.6989 | 268 | Ham | C | 120s |
| 128.2870 | 128.4372 | 365 | Kai | C | 30s |
| 128.4057 | 128.4337 | 10 | Shu | I | 180s |
| 128.7641 | 128.9829 | 284 | SWI | C | 60s |

*BJD − 2455500.
\(\ddagger\) Number of observations.
\(\|\) Observer’s code.
\(#\) Filter. “C” means no filter (clear).
Table 4. (Continued.)

| Start*      | End*      | N§ | obs∥ | sys# | exp  |
|-------------|-----------|----|------|------|------|
| 128.9004    | 129.2091  | 800| Siz  | C    | 30s  |
| 128.9373    | 129.3308  | 656| Aka  | C    | 60s  |
| 129.0103    | 129.1282  | 189| Mhh  | Ic   | 45s  |
| 129.0106    | 129.1285  | 189| Mhh  | V    | 45s  |
| 129.0571    | 129.3483  | 778| Ioh  | C    | 15s  |
| 129.2803    | 129.5875  | 197| Ham  | C    | 120s |
| 129.6139    | 129.9844  | 475| SWI  | C    | 60s  |
| 129.7005    | 129.8405  | 90 | BBo  | C    | 120s |
| 129.7285    | 129.9161  | 293| Kra  | C    | 50s  |
| 130.0086    | 130.3436  | 842| Ioh  | C    | 15s  |
| 130.0463    | 130.1540  | 291| Siz  | C    | 30s  |
| 130.2247    | 130.4445  | 144| Shu  | B    | 20s  |
| 130.2252    | 130.4418  | 139| Shu  | V    | 20s  |
| 130.2256    | 130.4513  | 69 | Shu  | R    | 40s  |
| 130.3610    | 130.4372  | 14 | Shu  | U    | 90s  |
| 130.5846    | 130.7521  | 99 | BBo  | C    | 120s |
| 130.7257    | 130.9158  | 301| Kra  | C    | 50s  |
| 130.7466    | 130.9762  | 298| SWI  | C    | 60s  |
| 130.9167    | 131.0890  | 204| Aka  | C    | 60s  |
| 131.0232    | 131.2186  | 455| Siz  | C    | 30s  |
| 131.1061    | 131.3436  | 617| Ioh  | C    | 15s  |
| 131.6867    | 131.9162  | 360| Kra  | C    | 50s  |
| 132.0153    | 132.2564  | 998| OKU  | C    | 15s  |
| 132.0286    | 132.3419  | 823| Ioh  | C    | 15s  |
| 132.1041    | 132.3238  | 304| Aka  | C    | 60s  |
| 132.3389    | 132.3956  | 34 | SAO  | V    | 120s |
| 132.3389    | 132.6486  | 104| Shu  | V    | 60s  |
| 132.4762    | 132.5614  | 41 | Shu  | U    | 60s  |
| 132.4778    | 132.6518  | 73 | Shu  | R    | 60s  |
| 132.5630    | 132.6349  | 55 | Shu  | B    | 60s  |
| 132.6500    | 132.6512  | 2  | Shu  | I    | 60s  |
| 132.7368    | 132.9163  | 285| Kra  | C    | 50s  |
| 132.9279    | 133.1359  | 279| Aka  | C    | 60s  |
| 133.1202    | 133.2554  | 280| OKU  | C    | 30s  |
| 133.2700    | 133.6167  | 312| CRI  | C    | 90s  |
| 133.9088    | 134.3309  | 1062| Ioh | C    | 15s  |
| 133.9245    | 134.2841  | 492| Aka  | C    | 60s  |
| 134.1900    | 134.4818  | 248| CRI  | C    | 90s  |
| 134.2789    | 134.3441  | 39 | SAO  | V    | 60s  |
| 134.2789    | 134.3441  | 39 | Shu  | V    | 60s  |
| 134.4224    | 134.5509  | 794| Ter  | C    | 10s  |
| 134.7312    | 134.8743  | 226| Kra  | C    | 50s  |
| 134.7416    | 134.9449  | 262| SWI  | C    | 60s  |
| 135.1712    | 135.5455  | 1348| CRI | C    | 15s  |
| 135.2032    | 135.6222  | 371| Ter  | C    | 90s  |
| 135.2039    | 135.3027  | 268| Ioh  | C    | 15s  |
| 135.2756    | 135.4712  | 469| Kai  | C    | 30s  |
| 135.4246    | 135.5254  | 322| VIR  | C    | 20s  |
| 136.1744    | 136.5891  | 1583| Ter | C    | 30s  |
| 136.1880    | 136.5348  | 294| CRI  | C    | 90s  |

* BJD − 2455500.
§ Number of observations.
∥ Observer’s code.
# Filter. “C” means no filter (clear).
Table 4. (Continued.)

| Start* | End* | N§ | obs‖ | sys# | exp  |
|--------|------|----|------|------|------|
| 136.2261 | 136.3512 | 171 | Aka | C | 60s |
| 136.2817 | 136.6931 | 267 | Ham | C | 120s |
| 136.3263 | 136.4211 | 303 | VIR | C | 20s |
| 136.3305 | 136.4522 | 295 | deM | C | 30s |
| 136.9200 | 137.3281 | 528 | Aka | C | 60s |
| 137.0363 | 137.3222 | 748 | Ioh | C | 15s |
| 137.1971 | 137.4967 | 95 | CRI | C | 30s |
| 137.3264 | 137.4226 | 244 | VIR | C | 30s |
| 137.4029 | 137.6006 | 334 | deM | C | 40s |
| 137.7229 | 137.8747 | 240 | Kra | C | 50s |
| 137.7254 | 137.8994 | 226 | SWI | C | 60s |
| 137.9264 | 138.3264 | 960 | Siz | C | 30s |
| 137.9326 | 138.3555 | 1056 | Ioh | C | 15s |
| 137.9491 | 138.1159 | 211 | OUS | C | 60s |
| 138.0873 | 138.3314 | 333 | Aka | C | 60s |
| 138.1119 | 138.2418 | 204 | OKU | C | 30s |
| 138.3358 | 138.4769 | 181 | deM | C | 40s |
| 138.7122 | 138.9233 | 274 | SWI | C | 60s |
| 138.7201 | 138.8744 | 242 | Kra | C | 50s |
| 139.4819 | 139.6697 | 220 | deM | C | 40s |
| 139.9114 | 140.2276 | 836 | Siz | C | 30s |
| 139.9292 | 140.1715 | 264 | Aka | C | 60s |
| 140.0031 | 140.2083 | 488 | Ioh | C | 15s |
| 140.3493 | 140.6668 | 304 | deM | C | 40s/60s |
| 140.7078 | 140.9175 | 272 | SWI | C | 60s |
| 140.7145 | 140.8744 | 251 | Kra | C | 50s |
| 141.0274 | 141.2366 | 481 | Ioh | C | 15s |
| 141.1954 | 141.5325 | 209 | CRI | C | 120s |
| 141.3484 | 141.6251 | 320 | deM | C | 60s |
| 141.4013 | 141.5861 | 55 | Shu | R | 90s |
| 141.4029 | 141.5821 | 39 | Shu | V | 90s |
| 141.4048 | 141.5810 | 37 | Shu | B | 90s |
| 141.4842 | 141.4867 | 2 | Shu | I | 20s |
| 141.4951 | 141.5846 | 15 | Shu | U | 90s |
| 142.2938 | 142.6185 | 212 | Ham | C | 120s |
| 142.3131 | 142.5250 | 80 | Shu | WF | 90s |
| 142.3206 | 142.5851 | 46 | Shu | B | 90s |
| 142.3220 | 142.6063 | 49 | Shu | V | 90s |
| 142.3230 | 142.6080 | 48 | Shu | R | 90s |
| 142.9223 | 143.3345 | 488 | Aka | C | 60s |
| 142.9728 | 143.2752 | 366 | OUS | C | 60s |
| 143.2329 | 143.2755 | 13 | Shu | R | 90s |
| 143.2344 | 143.2711 | 12 | Shu | V | 90s |
| 143.2067 | 143.2745 | 2 | Shu | B | 90s |
| 143.2798 | 143.4127 | 88 | CRI | C | 120s |
| 143.2931 | 143.6647 | 242 | Ham | C | 120s |
| 143.4544 | 143.6456 | 348 | deM | C | 60s |
| 143.7062 | 143.8741 | 264 | Kra | C | 50s |
| 143.9605 | 144.0718 | 151 | Mhh | Ic | 60s |
| 143.9608 | 144.0721 | 151 | Mhh | V | 60s |
| 143.9658 | 144.2904 | 403 | Aka | C | 60s |

*BJD−2455500.

§Number of observations.

‖Observer’s code.

#Filter. “C” means no filter (clear).
Table 4. (Continued.)

| Start   | End   | N$^\S$ | sys# | exp |
|---------|-------|--------|------|-----|
| 144.0835  | 144.2111  | 331    | Siz  | C   | 30s  |
| 144.2552  | 144.6427  | 875    | DPV  | C   | 30s  |
| 144.2733  | 144.5137  | 72     | Shu  | R   | 90s  |
| 144.2936  | 144.6646  | 242    | Ham  | C   | 120s |
| 144.3105  | 144.4844  | 44     | Shu  | V   | 90s  |
| 144.3118  | 144.4858  | 45     | Shu  | B   | 90s  |
| 144.4802  | 144.6598  | 350    | deM  | C   | 40s  |
| 144.7042  | 144.8743  | 267    | Kra  | C   | 50s  |
| 144.9214  | 145.2836  | 483    | Aka  | C   | 60s  |
| 144.9913  | 145.2504  | 693    | Ioh  | C   | 15s  |
| 145.0909  | 145.2778  | 254    | OUS  | C   | 60s  |
| 145.2830  | 145.5176  | 99     | Shu  | R   | 90s  |
| 145.2844  | 145.5144  | 67     | Shu  | V   | 90s  |
| 145.2855  | 145.4412  | 30     | Shu  | U   | 90s  |
| 145.2881  | 145.5136  | 65     | Shu  | B   | 90s  |
| 145.2924  | 145.4432  | 7      | Shu  | I   | 90s  |
| 145.3090  | 145.6646  | 229    | Ham  | C   | 120s |
| 145.5867  | 145.9360  | 649    | Kra  | C   | 40s  |
| 146.1105  | 146.2795  | 121    | OUS  | C   | 60s  |
| 146.2122  | 146.6082  | 273    | CRI  | C   | 120s |
| 146.6644  | 146.9002  | 308    | SWI  | C   | 60s  |
| 146.7105  | 146.8745  | 254    | Kra  | C   | 50s  |
| 146.9158  | 147.2935  | 455    | Aka  | C   | 60s  |
| 146.9547  | 147.2923  | 897    | Ioh  | C   | 15s  |
| 147.0929  | 147.2741  | 241    | OUS  | C   | 60s  |
| 147.2127  | 147.4845  | 374    | CRI  | C   | 60s  |
| 147.3700  | 147.5056  | 488    | Ter  | C   | 15s  |
| 147.5863  | 147.8116  | 350    | Kra  | C   | 50s  |
| 147.6696  | 147.9005  | 302    | SWI  | C   | 60s  |
| 147.9645  | 148.1953  | 264    | Ioh  | C   | 15s  |
| 148.0463  | 148.3163  | 367    | Aka  | C   | 60s  |
| 148.3025  | 148.4106  | 70     | Ham  | C   | 120s |
| 148.3062  | 148.4736  | 58     | Shu  | R   | 90s  |
| 148.3130  | 148.4724  | 42     | Shu  | V   | 90s  |
| 148.3144  | 148.4341  | 27     | Shu  | B   | 90s  |
| 148.3566  | 148.4379  | 221    | DPV  | CR  | 30s  |
| 148.5862  | 148.8121  | 355    | Kra  | C   | 50s  |
| 148.6593  | 148.9061  | 316    | SWI  | C   | 60s  |
| 148.9362  | 149.1895  | 342    | Aka  | C   | 60s  |
| 149.0315  | 149.1995  | 667    | KU   | C   | 15s  |
| 149.1008  | 149.3003  | 535    | Ioh  | C   | 15s  |
| 149.2200  | 149.5110  | 130    | CRI  | C   | 180s |
| 149.2986  | 149.6230  | 209    | Ham  | C   | 120s |
| 149.3193  | 149.4617  | 217    | deM  | C   | 60s  |
| 149.3365  | 149.6012  | 433    | VIR  | C   | 45s  |
| 149.5876  | 149.7499  | 255    | Kra  | C   | 50s  |
| 150.2488  | 150.3154  | 16     | CRI  | C   | 180s |
| 150.2634  | 150.6256  | 959    | DPV  | C   | 30s  |
| 150.2647  | 150.3412  | 33     | Shu  | R   | 90s  |
| 150.2657  | 150.3402  | 15     | Shu  | V   | 90s  |
| 150.2733  | 150.3424  | 15     | Shu  | B   | 90s  |

$^\ast$BJD$-2455500$.
$^\S$Number of observations.
$^\|$Observer’s code.
$^\#$Filter. “C” means no filter (clear).
Table 4. (Continued.)

| Start*   | End*   | N§  | obs∥ | sys# | exp  |
|----------|--------|-----|------|------|------|
| 150.2973 | 150.6230 | 211 | Ham  | C    | 120s |
| 150.5371 | 150.6447 | 128 | deM  | C    | 60s  |
| 150.6679 | 150.7775 | 143 | SWI  | C    | 60s  |
| 150.9174 | 151.2824 | 485 | Aka  | C    | 60s  |
| 151.0805 | 151.2645 | 253 | OUS  | C    | 60s  |
| 151.1086 | 151.2223 | 453 | KU   | C    | 15s  |
| 151.3637 | 151.5775 | 93  | Shu  | R    | 90s  |
| 151.3657 | 151.5782 | 49  | Shu  | V    | 90s  |
| 151.3667 | 151.5792 | 50  | Shu  | B    | 90s  |
| 151.3750 | 151.5476 | 32  | Shu  | U    | 90s  |
| 151.4174 | 151.6269 | 534 | DPV  | C    | 30s  |
| 151.4285 | 151.6036 | 288 | VIR  | C    | 45s  |
| 151.5277 | 151.6413 | 141 | deM  | C    | 60s  |
| 151.9442 | 152.2237 | 347 | Aka  | C    | 60s  |
| 151.9501 | 152.2974 | 934 | Ioh  | C    | 15s  |
| 152.0069 | 152.1995 | 882 | KU   | C    | 15s  |
| 152.0836 | 152.2618 | 246 | OUS  | C    | 60s  |
| 152.2624 | 152.3915 | 35  | Shu  | R    | 90s  |
| 152.2634 | 152.3921 | 29  | Shu  | V    | 90s  |
| 152.2656 | 152.3907 | 25  | Shu  | B    | 90s  |
| 152.2728 | 152.3892 | 26  | Shu  | U    | 90s  |
| 152.3846 | 152.5000 | 270 | DPV  | C    | 30s  |
| 152.5003 | 152.5949 | 224 | DPV  | C    | 30s  |
| 152.5377 | 152.6399 | 125 | deM  | C    | 60s  |
| 152.5889 | 152.7499 | 253 | Kra  | C    | 50s  |
| 152.6772 | 152.9022 | 292 | SWI  | C    | 60s  |
| 152.9345 | 153.2607 | 442 | Aka  | C    | 60s  |
| 153.0965 | 153.2585 | 428 | Ioh  | C    | 15s  |
| 153.1051 | 153.2036 | 306 | KU   | C    | 15s  |
| 153.2177 | 153.4463 | 107 | CRI  | C    | 120s |
| 153.5892 | 153.7501 | 250 | Kra  | C    | 50s  |
| 153.6620 | 153.9005 | 312 | SWI  | C    | 60s  |
| 153.9668 | 154.0239 | 73  | Aka  | C    | 60s  |
| 154.4154 | 154.6404 | 87  | Shu  | C    | 90s  |
| 154.5897 | 154.7482 | 249 | Kra  | C    | 50s  |
| 154.9240 | 155.2622 | 461 | Aka  | C    | 60s  |
| 155.0849 | 155.2164 | 603 | KU   | C    | 15s  |
| 155.0850 | 155.2605 | 240 | OUS  | C    | 60s  |
| 155.2590 | 155.6399 | 168 | Shu  | C    | 180s |
| 155.2774 | 155.6197 | 838 | DPV  | C    | 30s  |
| 155.2937 | 155.5186 | 133 | CRI  | C    | 120s |
| 155.9372 | 156.2702 | 451 | Aka  | C    | 60s  |
| 155.9690 | 156.3022 | 895 | Ioh  | C    | 15s  |
| 156.0398 | 156.2140 | 793 | KU   | C    | 15s  |
| 156.4494 | 156.6226 | 259 | deM  | C    | 50s  |
| 156.9365 | 157.2170 | 375 | Aka  | C    | 60s  |
| 156.9765 | 157.2417 | 721 | Ioh  | C    | 15s  |
| 156.9823 | 157.1990 | 990 | KU   | C    | 15s  |
| 157.2723 | 157.6329 | 148 | Shu  | Rc   | 90s  |
| 157.2967 | 157.5725 | 364 | DPV  | C    | 30s  |
| 157.3123 | 157.3429 | 51  | VIR  | C    | 45s  |

*B JD = 2455500.
§Number of observations.
∥Observer’s code.
#Filter. “C” means no filter (clear).
| Start*  | End*   | N§  | obs∥ | sys# | exp  |
|---------|--------|-----|------|------|------|
| 157.4044 | 157.4497 | 61  | Shu  | Ic   | 20s  |
| 157.9871 | 158.2296 | 657 | Ioh  | C    | 15s  |
| 158.0054 | 158.1344 | 274 | OKU  | C    | 30s  |
| 158.3197 | 158.6230 | 197 | Ham  | C    | 120s |
| 158.5591 | 158.6887 | 402 | Rui  | C    | 15s  |
| 158.9997 | 159.1483 | 641 | OKU  | C    | 15s  |
| 160.2383 | 160.3212 | 55  | CRI  | C    | 120s |
| 160.3189 | 160.6231 | 198 | Ham  | C    | 120s |
| 161.3222 | 161.6231 | 196 | Ham  | C    | 120s |
| 161.9494 | 162.2409 | 375 | Aka  | C    | 60s  |
| 162.3239 | 162.6230 | 192 | Ham  | C    | 120s |
| 162.5021 | 162.6128 | 54  | Shu  | Rc   | 90s  |
| 162.9359 | 163.2250 | 375 | Aka  | C    | 60s  |
| 163.9436 | 164.2228 | 599 | OKU  | C    | 30s  |
| 163.9660 | 164.2264 | 351 | Aka  | C    | 60s  |
| 164.9750 | 164.2913 | 853 | Ioh  | C    | 15s  |
| 164.3312 | 164.6231 | 186 | Ham  | C    | 120s |
| 164.9329 | 164.9825 | 131 | Ioh  | C    | 15s  |
| 165.0162 | 165.2082 | 743 | KU   | C    | 15s  |
| 165.0416 | 165.1812 | 300 | OKU  | C    | 30s  |
| 165.0940 | 165.2227 | 174 | OUS  | C    | 60s  |
| 165.1022 | 165.2505 | 206 | Aka  | C    | 60s  |
| 165.2558 | 165.3583 | 35  | Shu  | R    | 90s  |
| 165.2660 | 165.3550 | 32  | Shu  | V    | 90s  |
| 165.3063 | 165.5346 | 288 | DPV  | C    | 60s  |
| 165.3159 | 165.3567 | 13  | Shu  | B    | 90s  |
| 165.3512 | 165.5214 | 108 | Shu  | C    | 90s  |
| 165.3512 | 165.5214 | 108 | Shu  | Rc   | 90s  |
| 165.9782 | 166.0934 | 175 | Ioh  | C    | 15s  |
| 166.0009 | 166.0775 | 105 | Aka  | C    | 60s  |
| 167.3479 | 167.5160 | 110 | Ham  | C    | 120s |
| 167.4106 | 167.4995 | 310 | Rui  | C    | 15s  |
| 168.0178 | 168.2906 | 377 | Aka  | C    | 60s  |
| 168.0300 | 168.2075 | 238 | OUS  | C    | 60s  |
| 168.2850 | 168.6185 | 171 | Shu  | Rc   | 90s  |
| 168.3369 | 168.4207 | 18  | Shu  | R    | 90s  |
| 168.3381 | 168.4219 | 19  | Shu  | V    | 90s  |
| 168.3395 | 168.4193 | 17  | Shu  | B    | 90s  |
| 169.3892 | 169.6187 | 77  | Shu  | Rc   | 90s  |
| 170.4480 | 170.6076 | 72  | Shu  | Rc   | 90s  |
| 170.9865 | 171.2319 | 183 | Aka  | C    | 60s  |
| 171.3301 | 171.6231 | 192 | Ham  | C    | 120s |
| 171.9608 | 172.1662 | 272 | Aka  | C    | 60s  |
| 172.0676 | 172.2049 | 186 | OUS  | C    | 60s  |
| 172.0909 | 172.2196 | 543 | KU   | C    | 15s  |
| 172.2245 | 172.3319 | 51  | CRI  | C    | 120s |
| 172.2860 | 172.5831 | 404 | DPV  | C    | 30s  |
| 172.3290 | 172.6231 | 182 | Ham  | C    | 120s |
| 172.4002 | 172.4486 | 65  | IMi  | C    | 60s  |
| 173.0345 | 173.1216 | 214 | KU   | C    | 15s  |
| 173.2521 | 173.4699 | 143 | CRI  | C    | 120s |

* BJD − 2455500.
§ Number of observations.
∥ Observer’s code.
# Filter. “C” means no filter (clear).
| Start*  | End*  | N§  | obs∥ | sys# | exp |
|---------|-------|-----|------|------|-----|
| 173.2855 | 173.6153 | 237 | Shu  | Rc   | 30s |
| 173.2861 | 173.3729 | 22  | Shu  | B    | 90s |
| 173.2866 | 173.3738 | 18  | Shu  | V    | 90s |
| 173.2881 | 173.3752 | 19  | Shu  | U    | 90s |
| 173.3691 | 173.5789 | 274 | IMi  | V    | 60s |
| 174.2897 | 174.3630 | 98  | DPV  | C    | 30s |
| 174.2927 | 174.3869 | 35  | Shu  | B    | 90s |
| 174.2939 | 174.3852 | 34  | Shu  | U    | 90s |
| 174.2951 | 174.5946 | 417 | Shu  | Rc   | 20s |
| 174.2974 | 174.3864 | 34  | Shu  | V    | 90s |
| 174.2978 | 174.3873 | 15  | Shu  | Ic   | 90s |
| 175.0449 | 175.2423 | 270 | Aka  | C    | 60s |
| 175.2126 | 175.2799 | 253 | KU   | C    | 15s |
| 175.9957 | 176.2547 | 343 | Aka  | C    | 60s |
| 176.0491 | 176.1949 | 565 | KU   | C    | 15s |
| 176.0719 | 176.2121 | 371 | Ioh  | C    | 15s |
| 176.3037 | 176.4764 | 226 | CRI  | C    | 60s |
| 176.9412 | 177.1276 | 478 | Siz  | C    | 30s |
| 177.0146 | 177.2097 | 564 | KU   | C    | 15s |
| 177.3023 | 177.4898 | 248 | DPV  | C    | 30s |
| 177.9824 | 178.2447 | 354 | Aka  | C    | 60s |
| 178.2781 | 178.3799 | 135 | CRI  | C    | 60s |
| 178.2950 | 178.3388 | 30  | Shu  | C    | 30s |
| 178.3756 | 178.5548 | 201 | deM  | C    | 50s |
| 178.4010 | 178.5131 | 184 | VIR  | C    | 45s |
| 179.2933 | 179.4487 | 71  | CRI  | C    | 180s|
| 179.3625 | 179.5553 | 240 | deM  | C    | 50s |
| 180.0578 | 180.2164 | 195 | Aka  | C    | 60s |
| 180.2321 | 180.3111 | 366 | KU   | C    | 15s |
| 180.3077 | 180.5079 | 92  | CRI  | C    | 180s|
| 181.0041 | 181.1988 | 711 | KU   | C    | 15s |
| 181.0509 | 181.1820 | 358 | Ioh  | C    | 15s |
| 182.3018 | 182.5007 | 133 | CRI  | C    | 120s|
| 182.3985 | 182.5936 | 165 | Ham  | C    | 90s |
| 182.4023 | 182.4603 | 79  | IMi  | V    | 60s |
| 183.0322 | 183.1542 | 294 | Ioh  | C    | 15s |
| 183.1535 | 183.1918 | 120 | KU   | C    | 15s |
| 183.3500 | 183.6056 | 312 | Ham  | C    | 60s |
| 183.9424 | 184.1185 | 223 | Aka  | C    | 60s |
| 183.9892 | 184.1896 | 249 | KU   | C    | 15s |
| 184.2969 | 184.4258 | 131 | DPV  | C    | 30s |
| 184.3007 | 184.4606 | 117 | CRI  | C    | 110s|
| 184.3566 | 184.6071 | 305 | Ham  | C    | 60s |
| 185.3574 | 185.6050 | 300 | Ham  | C    | 60s |
| 185.3850 | 185.5023 | 54  | CRI  | C    | 180s|
| 186.3510 | 186.6053 | 307 | Ham  | C    | 60s |
| 186.9646 | 187.2131 | 339 | Aka  | C    | 60s |
| 186.9663 | 187.1825 | 941 | KU   | C    | 15s |
| 187.3066 | 187.5859 | 221 | Shu  | C    | 60s |
| 187.3450 | 187.6042 | 225 | Ham  | C    | 90s |
| 188.2825 | 188.5714 | 190 | Shu  | C    | 90s |

*BJD−2455500.

§Number of observations.
∥Observer’s code.
#Filter. “C” means no filter (clear).
Table 4. (Continued.)

| Start  | End   | \(N\) | obs | sys | exp   |
|--------|-------|-------|-----|-----|-------|
| 188.2893 | 188.4902 | 133   | CRI | C   | 90s   |
| 188.3728 | 188.6033 | 168   | Ham | C   | 100s  |
| 189.0673 | 189.2310 | 422   | Ioh | C   | 15s   |
| 189.2754 | 189.4815 | 141   | CRI | C   | 120s  |
| 189.9888 | 190.1950 | 274   | Aka | C   | 60s   |
| 190.0895 | 190.1488 | 75    | KU  | C   | 15s   |
| 190.2917 | 190.5815 | 198   | Shu | C   | 90s   |
| 190.3822 | 190.5574 | 539   | Rui | C   | 15s   |
| 190.4082 | 190.5689 | 209   | IMi | C   | 60s   |
| 191.3340 | 191.5771 | 112   | Shu | C   | 90s   |
| 192.2719 | 192.4692 | 106   | CRI | C   | 150s  |
| 193.3115 | 193.5542 | 322   | DPV | C   | 30s   |
| 194.3905 | 194.6037 | 182   | Ham | C   | 90s   |
| 194.9459 | 195.1434 | 273   | Aka | C   | 60s   |
| 195.9465 | 196.1729 | 307   | Aka | C   | 60s   |
| 197.2622 | 197.4690 | 97    | CRI | C   | 180s  |
| 198.2712 | 198.4347 | 77    | CRI | C   | 180s  |
| 199.0537 | 199.1781 | 169   | Aka | C   | 60s   |
| 199.2778 | 199.4153 | 63    | CRI | C   | 180s  |
| 199.9491 | 200.1868 | 325   | Aka | C   | 60s   |
| 200.0005 | 200.1284 | 498   | KU  | C   | 15s   |
| 200.2561 | 200.4086 | 72    | CRI | C   | 180s  |
| 200.3151 | 200.5465 | 295   | DPV | C   | 30s   |
| 200.9485 | 201.1505 | 278   | Aka | C   | 60s   |
| 201.0919 | 201.1445 | 182   | KU  | C   | 15s   |
| 201.2603 | 201.4184 | 73    | CRI | C   | 180s  |
| 201.9539 | 202.0385 | 84    | Aka | C   | 60s   |
| 202.0082 | 202.1413 | 381   | KU  | C   | 15s   |
| 202.3795 | 202.5834 | 174   | Ham | C   | 90s   |
| 203.3797 | 203.4749 | 73    | Ham | C   | 90s   |
| 204.3833 | 204.5628 | 152   | Ham | C   | 90s   |
| 205.2796 | 205.4469 | 73    | CRI | C   | 180s  |
| 205.9838 | 206.1055 | 100   | Aka | C   | 60s   |
| 206.2906 | 206.4196 | 60    | CRI | C   | 180s  |
| 207.2783 | 207.4128 | 63    | CRI | C   | 180s  |
| 207.3619 | 207.5292 | 179   | NKa | C   | 70s   |
| 208.2654 | 208.3942 | 50    | CRI | C   | 180s  |
| 209.2673 | 209.3585 | 43    | CRI | C   | 180s  |
| 210.2773 | 210.3011 | 9     | CRI | C   | 180s  |
| 211.3259 | 211.5250 | 246   | DPV | C   | 30s   |
| 211.3848 | 211.5817 | 169   | Ham | C   | 90s   |
| 212.3393 | 212.5117 | 238   | DPV | C   | 30s   |
| 212.3873 | 212.4283 | 20    | CRI | C   | 180s  |
| 213.2956 | 213.3106 | 8     | CRI | C   | 150s  |
| 214.2643 | 214.3814 | 55    | CRI | C   | 180s  |
| 214.3811 | 214.5731 | 165   | Ham | C   | 90s   |
| 215.0263 | 215.1139 | 113   | Aka | C   | 60s   |
| 216.9723 | 217.0540 | 109   | Aka | C   | 60s   |
| 218.0176 | 218.1189 | 137   | Aka | C   | 60s   |
| 218.2988 | 218.3742 | 36    | CRI | C   | 180s  |
| 219.2860 | 219.3598 | 35    | CRI | C   | 180s  |

*BJD−2455500.
§Number of observations.
∥Observer’s code.
#Filter. “C” means no filter (clear).
| Start*  | End*   | N§  | obs‖ | sys# | exp  |
|---------|--------|-----|------|------|------|
| 220.2784 | 220.3522 | 35  | CRI  | C    | 180s |
| 220.3614 | 220.3780 | 47  | DPV  | C    | 30s  |
| 221.2729 | 221.3488 | 36  | CRI  | C    | 180s |
| 222.2933 | 222.4011 | 47  | CRI  | C    | 180s |
| 233.9745 | 234.0597 | 119 | Aka  | C    | 60s  |
| 240.9856 | 241.0651 | 105 | Aka  | C    | 60s  |
| 252.9643 | 253.0706 | 145 | Aka  | C    | 60s  |
| 253.9688 | 254.0852 | 150 | Aka  | C    | 60s  |
| 255.0095 | 255.0776 | 93  | Aka  | C    | 60s  |
| 257.9896 | 258.0612 | 93  | Aka  | C    | 60s  |
| 258.9653 | 259.0434 | 109 | Aka  | C    | 60s  |
| 262.9793 | 263.0475 | 70  | Aka  | C    | 60s  |
| 400.6318 | 400.7674 | 170 | deM  | C    | 60s  |
| 401.6245 | 401.7610 | 177 | deM  | C    | 60s  |
| 402.5931 | 402.7667 | 224 | deM  | C    | 60s  |
| 405.1334 | 405.2534 | 187 | OKU  | C    | 30s  |
| 405.2411 | 405.3437 | 398 | KU   | C    | 15s  |
| 406.1739 | 406.2584 | 137 | OKU  | C    | 30s  |
| 407.2635 | 407.3860 | 274 | OKU  | C    | 30s  |
| 410.2192 | 410.3276 | 384 | KU   | C    | 15s  |
| 410.5449 | 410.7707 | 291 | deM  | C    | 60s  |
| 411.2529 | 411.3409 | 265 | KU   | C    | 15s  |
| 412.1101 | 412.2632 | 420 | OKU  | C    | 30s  |
| 412.1450 | 412.3155 | 240 | OUS  | C    | 60s  |
| 412.2951 | 412.3847 | 410 | KU   | C    | 15s  |
| 413.1334 | 413.3133 | 251 | OUS  | C    | 60s  |
| 413.1844 | 413.2627 | 168 | OKU  | C    | 30s  |
| 414.5778 | 414.7722 | 259 | deM  | C    | 50s  |
| 415.5750 | 415.7719 | 264 | deM  | C    | 50s  |
| 416.5745 | 416.7721 | 264 | deM  | C    | 50s  |
| 417.5298 | 417.7721 | 323 | deM  | C    | 50s  |
| 418.5337 | 418.7723 | 318 | deM  | C    | 50s  |
| 419.5141 | 419.7658 | 335 | deM  | C    | 50s  |
| 420.1247 | 420.2652 | 392 | OKU  | C    | 20s  |
| 420.3159 | 420.3691 | 126 | Mhh  | C    | 30s  |
| 421.1969 | 421.3432 | 485 | OKU  | C    | 20s  |
| 421.4615 | 421.7712 | 372 | deM  | C    | 60s  |
| 422.2400 | 422.3598 | 427 | KU   | C    | 15s  |
| 422.5797 | 422.7709 | 243 | deM  | C    | 60s  |
| 423.5737 | 423.7441 | 220 | deM  | C    | 60s  |
| 424.4237 | 424.5677 | 68  | CRI  | C    | 180s |
| 425.3279 | 425.3623 | 17  | CRI  | C    | 180s |
| 425.6594 | 425.7673 | 142 | deM  | C    | 60s  |
| 427.2441 | 427.3234 | 99  | OKU  | C    | 60s  |
| 429.4212 | 429.7636 | 507 | deM  | C    | 50s  |
| 430.2972 | 430.3898 | 111 | Aka  | C    | 60s  |
| 430.4310 | 430.7641 | 498 | deM  | C    | 50s  |
| 431.0769 | 431.3908 | 327 | Aka  | C    | 60s  |
| 431.2887 | 431.3262 | 187 | OKU  | C    | 10s  |
| 431.4491 | 431.7639 | 473 | deM  | C    | 50s  |
| 432.0758 | 432.3870 | 421 | Aka  | C    | 60s  |

*BJD−2455500.

§Number of observations.
‖Observer’s code.
#Filter. “C” means no filter (clear).
| Start* | End*  | N§  | obs∥ | sys# | exp   |
|--------|-------|-----|------|------|-------|
| 432.1526 | 432.2814 | 427 | OKU  | C    | 20s   |
| 432.4491 | 432.7222 | 393 | deM  | C    | 50s   |
| 432.7184 | 432.9505 | 549 | SWI  | C    | 30s   |
| 433.0257 | 433.1746 | 205 | Aka  | C    | 60s   |
| 433.1181 | 433.1680 | 94  | OKU  | C    | 30s   |
| 433.4813 | 433.7120 | 345 | deM  | C    | 50s   |
| 433.7205 | 433.9592 | 568 | SWI  | C    | 30s   |
| 434.1071 | 434.1765 | 177 | OKU  | C    | 30s   |
| 434.1626 | 434.3934 | 319 | Aka  | C    | 60s   |
| 434.5138 | 434.7672 | 372 | deM  | C    | 50s   |
| 435.5183 | 435.7497 | 347 | deM  | C    | 50s   |
| 436.1334 | 436.3947 | 673 | OKU  | C    | 30s   |
| 436.1764 | 436.3933 | 297 | Aka  | C    | 60s   |
| 437.4966 | 437.7652 | 401 | deM  | C    | 50s   |
| 437.7663 | 438.0500 | 641 | Ham  | C    | 30s   |
| 438.1536 | 438.3321 | 464 | OKU  | C    | 30s   |
| 438.1763 | 438.3509 | 164 | Aka  | C    | 90s   |
| 438.5217 | 438.7653 | 362 | deM  | C    | 50s   |
| 439.6275 | 439.7226 | 146 | deM  | C    | 50s   |
| 440.6808 | 441.0009 | 754 | Ham  | C    | 30s   |
| 443.5130 | 443.7650 | 382 | deM  | C    | 50s   |
| 444.0133 | 444.2663 | 326 | OKU  | C    | 60s   |
| 444.2022 | 444.3335 | 630 | KU   | C    | 15s   |
| 444.5645 | 444.7650 | 302 | deM  | C    | 50s   |
| 444.6546 | 444.7029 | 108 | Ham  | C    | 30s   |
| 444.7109 | 444.9329 | 291 | SWI  | C    | 60s   |
| 445.0188 | 445.0727 | 73  | OKU  | C    | 60s   |
| 445.7030 | 445.9290 | 293 | SWI  | C    | 60s   |
| 445.8825 | 446.0523 | 397 | Ham  | C    | 30s   |
| 446.2813 | 446.5418 | 115 | CRI  | C    | 180s  |
| 446.6058 | 446.7651 | 246 | deM  | C    | 50s   |
| 446.6962 | 446.9253 | 554 | SWI  | C    | 30s   |
| 446.8826 | 447.0524 | 400 | Ham  | C    | 30s   |
| 447.6844 | 447.9262 | 585 | SWI  | C    | 30s   |
| 447.8823 | 448.0522 | 400 | Ham  | C    | 30s   |
| 448.6161 | 448.7668 | 233 | deM  | C    | 50s   |
| 450.6018 | 450.7427 | 216 | deM  | C    | 50s   |
| 452.0434 | 452.2581 | 229 | OKU  | C    | 70s   |
| 452.6021 | 452.7675 | 175 | deM  | C    | 70s   |
| 452.6796 | 452.9170 | 570 | SWI  | C    | 30s   |
| 452.6944 | 452.8503 | 370 | Ham  | C    | 30s   |
| 453.1151 | 453.2357 | 166 | OUS  | C    | 60s   |
| 453.1175 | 453.2499 | 271 | OKU  | C    | 30s   |
| 453.8633 | 454.0501 | 440 | Ham  | C    | 30s   |
| 454.2662 | 454.5835 | 139 | CRI  | C    | 180s  |
| 454.6019 | 454.7676 | 256 | deM  | C    | 50s   |
| 455.2159 | 455.3197 | 142 | Aka  | C    | 60s   |
| 455.2260 | 455.6258 | 178 | CRI  | C    | 180s  |
| 455.7169 | 455.9063 | 456 | SWI  | C    | 30s   |
| 455.8659 | 456.0524 | 437 | Ham  | C    | 30s   |
| 456.6160 | 456.7662 | 232 | deM  | C    | 50s   |

*BJD − 2455500.

§Number of observations.

∥Observer’s code.

#Filter. “C” means no filter (clear).
Table 4. (Continued.)

| Start*   | End*   | N§  | obs∥ | sys# | exp |
|----------|--------|-----|------|------|-----|
| 456.6642 | 456.8992 | 568 | SWI  | C    | 30s |
| 457.1511 | 457.3774 | 210 | Aka  | C    | 90s |
| 457.4431 | 457.7029 | 632 | DPV  | C    | 30s |
| 457.7519 | 457.8948 | 348 | DPV  | C    | 30s |
| 457.8437 | 460.0401 | 2156| Ham  | C    | 80s |
| 458.0906 | 458.2346 | 192 | Aka  | C    | 60s |
| 458.4367 | 458.6848 | 630 | DPV  | C    | 30s |
| 459.1133 | 459.3638 | 329 | Aka  | C    | 30s |
| 459.4343 | 459.7012 | 643 | DPV  | C    | 30s |
| 459.7330 | 459.8952 | 395 | SWI  | C    | 30s |
| 460.1322 | 460.3618 | 309 | Aka  | C    | 60s |
| 460.4348 | 460.7003 | 290 | DPV  | C    | 30s |
| 460.6249 | 460.7658 | 213 | deM  | C    | 50s |
| 460.6403 | 460.8504 | 502 | SWI  | C    | 30s |
| 460.8967 | 461.0397 | 329 | Ham  | C    | 30s |
| 461.2501 | 461.3572 | 90  | Aka  | C    | 90s |
| 462.2115 | 462.3781 | 230 | Aka  | C    | 60s |
| 462.2386 | 462.6140 | 166 | CRI  | C    | 180s|
| 463.2313 | 463.4606 | 96  | CRI  | C    | 180s|
| 463.6202 | 463.8805 | 628 | SWI  | C    | 30s |
| 463.7050 | 463.9222 | 509 | Ham  | C    | 30s |
| 464.2403 | 464.3568 | 50  | CRI  | C    | 180s|
| 464.2898 | 464.7282 | 132 | Ham  | C    | 120s|
| 465.1728 | 465.3753 | 184 | Aka  | C    | 90s |
| 466.2170 | 466.3745 | 148 | Aka  | C    | 90s |
| 466.2457 | 466.7264 | 147 | Ham  | C    | 120s|
| 466.6072 | 466.8666 | 616 | SWI  | C    | 30s |
| 467.2329 | 467.3667 | 115 | Aka  | C    | 90s |
| 467.2831 | 467.5094 | 103 | CRI  | C    | 180s|
| 467.6049 | 467.8667 | 620 | SWI  | C    | 30s |
| 468.2095 | 468.3831 | 163 | Aka  | C    | 90s |
| 468.2364 | 468.3052 | 33  | CRI  | C    | 180s|
| 468.2570 | 468.7270 | 120 | Ham  | C    | 120s|
| 468.6957 | 468.8701 | 414 | CRI  | C    | 30s |
| 469.1586 | 469.3729 | 201 | Aka  | C    | 90s |
| 469.2565 | 469.3371 | 53  | Ham  | C    | 120s|
| 470.2396 | 470.4597 | 568 | DPV  | C    | 30s |
| 471.2298 | 471.4295 | 519 | DPV  | C    | 30s |
| 471.2369 | 471.3917 | 73  | CRI  | C    | 180s|
| 471.5972 | 471.7469 | 329 | Ham  | C    | 30s |
| 471.6105 | 471.8651 | 615 | SWI  | C    | 30s |
| 472.2240 | 472.2862 | 160 | DPV  | C    | 30s |
| 473.6029 | 473.8572 | 618 | SWI  | C    | 30s |
| 473.8614 | 473.9463 | 40  | APO  | R    | 180s|
| 473.8754 | 474.0234 | 445 | AKz  | C    | 30s |
| 475.1651 | 475.3750 | 197 | Aka  | C    | 90s |
| 476.1801 | 476.3762 | 184 | Aka  | C    | 90s |
| 476.6262 | 476.7501 | 192 | deM  | C    | 50s |
| 476.8672 | 477.0150 | 329 | Ham  | C    | 30s |
| 477.1710 | 477.3746 | 189 | Aka  | C    | 90s |
| 477.3819 | 477.7083 | 159 | Ham  | C    | 120s|

*BJD−2455500.
§Number of observations.
∥Observer’s code.
#Filter. “C” means no filter (clear).
Table 4. (Continued.)

| Start* | End*  | \(N^\|\) | \(\text{obs}^\|\) | sys# | exp |
|--------|-------|-----------|-----------|------|-----|
| 477.6162 | 477.7497 | 196 | deM | C | 50s |
| 478.1433 | 478.3747 | 186 | Aka | C | 90s |
| 478.2981 | 478.5067 | 135 | CRI | C | 120s |
| 478.3459 | 478.6813 | 801 | DPV | C | 30s |
| 478.6127 | 478.8440 | 563 | SWI | C | 30s |
| 478.6163 | 478.7547 | 261 | deM | C | 40s |
| 478.8616 | 479.0093 | 363 | Ham | C | 30s |
| 479.3933 | 479.4937 | 61 | Ham | C | 30s |
| 479.5935 | 479.7534 | 296 | deM | C | 40s |
| 479.8589 | 480.0067 | 358 | Ham | C | 30s |
| 480.5946 | 480.7275 | 180 | deM | C | 60s |
| 480.8561 | 481.0039 | 359 | Ham | C | 30s |
| 481.1812 | 481.4418 | 159 | CRI | C | 120s |
| 481.8533 | 482.0011 | 358 | Ham | C | 30s |
| 481.8559 | 481.9245 | 45 | APO | R | 90s |
| 482.3181 | 482.7385 | 746 | deM | C | 40s |
| 482.8505 | 482.9983 | 359 | AKz | C | 30s |
| 482.8516 | 482.9193 | 40 | APO | R | 90s |
| 483.8306 | 483.9266 | 60 | APO | R | 90s |
| 483.8478 | 483.9956 | 358 | AST | C | 30s |
| 484.0031 | 484.2401 | 340 | OKU | C | 50s |
| 484.1190 | 484.3624 | 326 | Aka | C | 30s |
| 484.3170 | 484.7377 | 754 | deM | C | 40s |
| 484.8433 | 484.9371 | 39 | APO | R | 90s |
| 484.8450 | 484.9424 | 234 | AKz | C | 30s |
| 484.9443 | 485.0886 | 498 | OKU | C | 20s |
| 485.1385 | 485.3630 | 311 | Aka | C | 60s |
| 485.3151 | 485.7127 | 723 | deM | C | 40s |
| 485.5883 | 485.7823 | 326 | LCO | B | 40s |
| 485.7142 | 485.9849 | 638 | SWI | C | 30s |
| 486.3223 | 486.7257 | 690 | deM | C | 40s |
| 486.7090 | 486.9844 | 646 | SWI | C | 30s |
| 486.8394 | 486.9869 | 358 | AKz | C | 30s |
| 487.1144 | 487.2779 | 226 | Aka | C | 60s |
| 487.2788 | 487.3998 | 308 | Kai | C | 30s |
| 487.3567 | 487.7180 | 647 | deM | C | 40s |
| 487.8366 | 487.9848 | 145 | AKz | C | 30s |
| 487.8438 | 487.9105 | 44 | APO | R | 90s |
| 488.2550 | 488.4635 | 524 | Kai | C | 30s |
| 489.3212 | 489.7185 | 725 | deM | C | 40s |
| 489.8252 | 489.9030 | 40 | APO | R | 90s |
| 489.8311 | 489.9792 | 145 | AKz | C | 30s |
| 490.3179 | 490.7164 | 729 | deM | C | 40s |
| 490.6968 | 491.0050 | 695 | SWI | C | 30s |
| 490.8283 | 490.9042 | 50 | APO | R | 30s |
| 490.8283 | 490.9769 | 145 | AKz | C | 30s |
| 491.2290 | 491.4005 | 415 | DPV | C | 30s |
| 491.7300 | 491.9911 | 608 | SWI | C | 30s |
| 491.8255 | 491.9736 | 144 | AKz | C | 30s |
| 491.8302 | 491.9222 | 60 | APO | R | 90s |
| 492.2372 | 492.3971 | 418 | DPV | C | 30s |

* BJD−2455500.

§Number of observations.

‖Observer’s code.

#Filter. “C” means no filter (clear).
| Start*  | End*  | N§  | obs∥  | sys#  | exp |
|--------|-------|-----|-------|-------|-----|
| 492.4199  | 492.7014  | 521  | deM  | C    | 40s  |
| 493.4081  | 493.6106  | 259  | Vir  | C    | 60s  |
| 493.4247  | 493.6060  | 336  | deM  | C    | 40s  |
| 494.3928  | 494.7048  | 404  | NDJ  | C    | 30s  |
| 494.4064  | 494.6458  | 440  | deM  | C    | 40s  |
| 495.2855  | 495.4244  | 44   | Ham  | C    | 120s |
| 495.4157  | 495.6274  | 392  | deM  | C    | 40s  |
| 496.3625  | 496.4006  | 100  | CRI  | C    | 30s  |
| 497.0856  | 497.3040  | 205  | Aka  | C    | 90s  |
| 497.0982  | 497.2520  | 200  | OKU  | C    | 60s  |
| 497.2990  | 497.3700  | 200  | CRI  | C    | 30s  |
| 497.6945  | 497.9609  | 630  | SWI  | C    | 30s  |
| 498.0884  | 498.3092  | 207  | Aka  | C    | 90s  |
| 498.5969  | 498.9545  | 347  | AKz  | C    | 30s  |
| 499.0839  | 499.3206  | 326  | Aka  | C    | 60s  |
| 499.3198  | 499.5987  | 394  | deM  | C    | 50s  |
| 499.3388  | 499.4757  | 40   | Ham  | C    | 120s |
| 499.7511  | 499.8799  | 40   | PSD  | V    | 120s |
| 499.9199  | 500.1075  | 449  | OKU  | C    | 30s  |
| 500.0322  | 500.1840  | 233  | OUS  | C    | 50s  |
| 500.1331  | 500.3276  | 268  | Aka  | C    | 60s  |
| 500.3244  | 500.5589  | 347  | deM  | C    | 50s  |
| 500.8087  | 500.8656  | 20   | PSD  | V    | 30s  |
| 501.1033  | 501.2522  | 140  | Aka  | C    | 90s  |
| 501.2746  | 501.4435  | 434  | Kai  | C    | 30s  |
| 501.2863  | 501.6939  | 125  | Ham  | C    | 120s |
| 501.3128  | 501.4528  | 208  | deM  | C    | 50s  |
| 501.6869  | 501.9574  | 640  | SWI  | C    | 30s  |
| 502.1009  | 502.2563  | 66   | Aka  | C    | 90s  |
| 502.2646  | 502.4477  | 469  | Kai  | C    | 30s  |
| 502.3016  | 502.6906  | 118  | Ham  | C    | 120s |
| 503.2504  | 503.5956  | 447  | DPV  | C    | 30s  |
| 503.2673  | 503.4509  | 476  | Kai  | C    | 30s  |
| 503.3325  | 503.4466  | 33   | Ham  | C    | 120s |
| 503.8009  | 503.8698  | 45   | APO  | R    | 120s |
| 504.2151  | 504.2519  | 18   | CRI  | C    | 180s |
| 504.2594  | 504.6283  | 492  | DPV  | C    | 30s  |
| 504.2781  | 504.3504  | 187  | Kai  | C    | 30s  |
| 504.3165  | 504.4709  | 229  | deM  | C    | 50s  |
| 504.4208  | 504.5776  | 106  | Pol  | V    | 60s  |
| 504.8086  | 504.8406  | 10   | PSD  | C    | 120s |
| 505.2564  | 505.6423  | 512  | DPV  | C    | 30s  |
| 505.3086  | 505.4327  | 35   | Ham  | C    | 120s |
| 505.3151  | 505.4790  | 232  | deM  | C    | 50s  |
| 506.2276  | 506.5491  | 148  | CRI  | C    | 180s |
| 506.2974  | 506.6841  | 117  | Ham  | C    | 120s |
| 506.3128  | 506.4788  | 247  | deM  | C    | 50s  |
| 507.0530  | 507.3031  | 232  | Aka  | C    | 90s  |
| 507.3217  | 507.6148  | 181  | CRI  | C    | 180s |
| 507.4257  | 507.4697  | 304  | DPV  | C    | 30s  |
| 507.2747  | 507.4275  | 395  | Kai  | C    | 30s  |

*BJD−2455500.
§Number of observations.
∥Observer’s code.
#Filter. “C” means no filter (clear).
Table 4. (Continued.)

| Start* | End*  | N§ | obs∥ | sys# | exp  |
|--------|-------|----|------|------|------|
| 508.0741 | 508.2984 | 204 | Aka C | 90s  |
| 508.3443 | 508.6279 | 423 | deM C | 50s  |
| 508.6670 | 508.9697 | 725 | SWI C | 30s  |
| 508.7893 | 508.8575 | 45  | APO R | 120s |
| 509.2404 | 509.6015 | 475 | DPV C | 30s  |
| 509.2740 | 509.4287 | 400 | Kai C | 30s  |
| 509.2960 | 509.4775 | 120 | Ham C | 120s |
| 509.3142 | 509.6609 | 486 | deM C | 50s  |
| 509.3807 | 509.4024 | 27  | Vir C | 30s  |
| 509.6621 | 509.9606 | 712 | SWI C | 30s  |
| 510.2730 | 510.6325 | 442 | DPV C | 30s  |
| 510.2974 | 510.4779 | 118 | Ham C | 120s |
| 510.7116 | 510.9636 | 600 | SWI C | 30s  |
| 511.2568 | 511.6364 | 492 | DPV C | 30s  |
| 511.2986 | 511.4780 | 116 | Ham C | 120s |
| 511.3313 | 511.6014 | 215 | CRI C | 100s |
| 511.6616 | 511.9714 | 677 | SWI C | 30s  |
| 511.7843 | 511.8526 | 45  | APO R | 120s |
| 512.1064 | 512.1975 | 86  | Aka C | 90s  |
| 512.3448 | 512.5341 | 142 | CRI C | 100s |
| 512.4610 | 512.6455 | 284 | deM C | 50s  |
| 513.3008 | 513.4357 | 89  | Ham C | 120s |
| 513.3464 | 513.5437 | 295 | deM C | 50s  |
| 513.6533 | 513.9256 | 650 | SWI C | 30s  |
| 514.0302 | 514.2753 | 230 | Aka C | 90s  |
| 514.3210 | 514.6426 | 509 | deM C | 50s  |
| 514.6667 | 514.9506 | 678 | SWI C | 30s  |
| 515.0450 | 515.2708 | 212 | Aka C | 90s  |
| 515.3041 | 515.4358 | 87  | Ham C | 120s |
| 515.3188 | 515.5408 | 326 | deM C | 50s  |
| 515.6622 | 515.9495 | 680 | SWI C | 30s  |
| 516.6583 | 516.9533 | 697 | SWI C | 30s  |
| 518.6527 | 518.9470 | 695 | SWI C | 30s  |
| 519.0029 | 519.1708 | 230 | OKU C | 60s  |
| 519.0214 | 519.2667 | 230 | Aka C | 90s  |
| 519.2799 | 519.4124 | 350 | Kai C | 30s  |
| 519.3333 | 519.5502 | 275 | Vir C | 60s  |
| 519.6225 | 519.8238 | 128 | APO R | 120s |
| 519.9808 | 520.0929 | 150 | OKU C | 60s  |
| 520.2885 | 520.3818 | 164 | Kai C | 30s  |
| 520.3317 | 520.5676 | 300 | Vir C | 60s  |
| 521.0101 | 521.2758 | 242 | Aka C | 90s  |
| 521.3434 | 521.4133 | 90  | Vir C | 60s  |
| 521.6488 | 521.9501 | 706 | SWI C | 30s  |
| 521.9281 | 522.0740 | 188 | OKU C | 60s  |
| 522.2675 | 522.5786 | 274 | CRI C | 90s  |
| 522.6423 | 522.8950 | 590 | SWI C | 30s  |
| 523.0150 | 523.1533 | 190 | Aka C | 60s  |
| 523.2013 | 523.4273 | 342 | CRI C | 50s  |
| 524.2836 | 524.4310 | 389 | Kai C | 30s  |
| 525.0338 | 525.2298 | 183 | Aka C | 90s  |

*BJD – 2455500.
§Number of observations.
∥Observer’s code.
#Filter. “C” means no filter (clear).
Table 4. (Continued.)

| Start* | End*  | N§  | obs∥ | sys# | exp |
|--------|-------|-----|------|------|-----|
| 525.1277 | 525.2002 | 100 | OKU  | C    | 60s |
| 525.3529 | 525.6127 | 394 | deM  | C    | 50s |
| 525.7207 | 525.9603 | 518 | SWI  | C    | 30s |
| 526.1167 | 526.2295 | 142 | OKU  | C    | 60s |
| 526.3328 | 526.6065 | 417 | deM  | C    | 50s |
| 526.3806 | 526.4500 | 190 | Kai  | C    | 30s |
| 527.2792 | 527.4898 | 274 | DPV  | C    | 60s |
| 527.6442 | 527.9110 | 623 | SWI  | C    | 30s |
| 528.2642 | 528.5209 | 348 | DPV  | C    | 60s |
| 529.6486 | 529.7859 | 80  | APO  | R    | 140s|
| 529.9942 | 530.1486 | 122 | Aka  | C    | 90s |
| 530.3289 | 530.5774 | 365 | deM  | C    | 50s |
| 531.3075 | 531.3456 | 18  | CRI  | C    | 180s|
| 531.6870 | 531.9181 | 552 | SWI  | C    | 30s |
| 532.0508 | 532.1893 | 190 | OKU  | C    | 50s |
| 532.3580 | 532.5960 | 355 | deM  | C    | 50s |
| 532.9351 | 533.1373 | 260 | Aka  | C    | 60s |
| 533.0956 | 533.2099 | 157 | OKU  | C    | 60s |
| 533.2494 | 533.5481 | 406 | CRI  | C    | 60s |
| 533.3296 | 533.5460 | 311 | deM  | C    | 50s |
| 533.6436 | 533.9217 | 664 | SWI  | C    | 30s |
| 533.9785 | 534.2081 | 314 | Aka  | C    | 60s |
| 533.9785 | 534.2092 | 427 | OUS  | C    | 45s |
| 534.2506 | 534.4643 | 295 | CRI  | C    | 60s |
| 534.3441 | 534.5567 | 338 | deM  | C    | 50s |
| 534.3360 | 534.5821 | 153 | Ham  | C    | 120s|
| 534.6287 | 534.9207 | 697 | SWI  | C    | 30s |
| 535.0386 | 535.2630 | 260 | Aka  | C    | 60s |
| 535.0462 | 535.1690 | 449 | OKU  | C    | 15s |
| 535.3321 | 535.5365 | 308 | deM  | C    | 50s |
| 535.5784 | 535.6781 | 215 | LCO  | B    | 30s |
| 535.6222 | 535.9074 | 681 | SWI  | C    | 30s |
| 536.0508 | 536.1191 | 231 | OKU  | C    | 15s |
| 536.6184 | 536.8982 | 668 | SWI  | C    | 30s |
| 536.6505 | 536.8438 | 108 | APO  | R    | 120s|
| 537.3684 | 537.5250 | 200 | Vir  | C    | 60s |
| 538.3083 | 538.3851 | 206 | Kai  | C    | 30s |
| 538.4307 | 538.5733 | 220 | deM  | C    | 50s |
| 538.6251 | 538.9015 | 660 | SWI  | C    | 30s |
| 539.3493 | 539.5169 | 258 | deM  | C    | 50s |
| 540.2750 | 540.5251 | 345 | CRI  | C    | 60s |
| 540.3359 | 540.5327 | 298 | deM  | C    | 50s |
| 540.9447 | 541.2095 | 361 | Aka  | C    | 60s |
| 541.0791 | 541.1865 | 252 | OKU  | C    | 30s |
| 541.3390 | 541.5364 | 303 | deM  | C    | 50s |
| 541.9404 | 542.0951 | 209 | Aka  | C    | 60s |
| 542.3367 | 542.5314 | 295 | deM  | C    | 50s |
| 542.6230 | 542.8038 | 432 | SWI  | C    | 30s |
| 543.9660 | 544.2697 | 387 | Aka  | C    | 60s |
| 544.9395 | 545.1760 | 319 | Aka  | C    | 60s |
| 546.3242 | 546.5635 | 315 | DPV  | C    | 30s |

*BJD−2455500.

§Number of observations.

∥Observer’s code.

#Filter. “C” means no filter (clear).
Table 4. (Continued.)

| Start\*  | End\*  | N\§ | obs\∥ | sys\# | exp |
|----------|--------|-----|-------|-------|-----|
| 551.0375 | 551.1909 | 199 | Aka   | C     | 60s |
| 551.9365 | 552.1531 | 197 | Aka   | C     | 90s |
| 553.2850 | 553.4517 | 468 | CRI   | C     | 20s |
| 553.9543 | 554.1409 | 171 | Aka   | C     | 90s |
| 554.3447 | 554.5049 | 450 | CRI   | C     | 20s |
| 555.0010 | 555.1184 | 110 | Aka   | C     | 90s |
| 556.9497 | 557.1381 | 173 | Aka   | C     | 90s |
| 557.3725 | 557.5216 | 230 | deM   | C     | 50s |
| 557.9524 | 558.1406 | 145 | Aka   | C     | 90s |
| 559.0003 | 559.1310 | 122 | Aka   | C     | 90s |
| 559.9481 | 560.1253 | 165 | Aka   | C     | 90s |
| 563.9978 | 564.1136 | 156 | Aka   | C     | 60s |
| 569.3144 | 569.3755 | 74  | Vol   | Rc    | 60s |
| 570.0090 | 570.1217 | 104 | Aka   | C     | 90s |
| 570.9599 | 571.1088 | 137 | Aka   | C     | 90s |
| 574.0236 | 574.1456 | 101 | Aka   | C     | 90s |
| 574.9683 | 575.1525 | 172 | Aka   | C     | 90s |
| 575.9570 | 576.0648 | 97  | Aka   | C     | 90s |
| 576.9617 | 577.1256 | 137 | Aka   | C     | 90s |
| 577.6484 | 577.7664 | 281 | SWI   | C     | 30s |
| 581.9754 | 582.1114 | 181 | Aka   | C     | 60s |
| 588.9636 | 589.1050 | 196 | Aka   | C     | 60s |
| 590.6471 | 590.7641 | 280 | SWI   | C     | 30s |
| 591.9666 | 592.1211 | 214 | Aka   | C     | 60s |

\*BJD−2455500.  
\(\S\)Number of observations.  
\(\parallel\)Observer’s code.  
\(#\)Filter. "C" means no filter (clear).
Table 5. Log of the maximum timings of negative superhumps supercycle 2011 S1

| E  | The timings of maximum* | O - C | error |
|----|------------------------|-------|-------|
| 0  | 91.0210                | 0.0010| 0.0010|
| 1  | 91.0857                | 0.0034| 0.0014|
| 2  | 91.1366                | -0.0081| 0.0010|
| 3  | 91.2149                | 0.0079| 0.0004|
| 4  | 91.2706                | 0.0012| 0.0003|
| 5  | 91.3319                | 0.0002| 0.0003|
| 8  | 91.5213                | 0.0026| 0.0006|
| 9  | 91.5830                | 0.0020| 0.0003|
| 10 | 91.6479                | 0.0045| 0.0004|
| 11 | 91.7092                | 0.0035| 0.0005|
| 13 | 91.8352                | 0.0048| 0.0004|
| 14 | 91.8990                | 0.0063| 0.0005|
| 15 | 91.9561                | 0.0010| 0.0003|
| 16 | 92.0147                | -0.0028| 0.0011|
| 17 | 92.0853                | 0.0055| 0.0009|
| 18 | 92.1492                | 0.0071| 0.0006|
| 19 | 92.2114                | 0.0069| 0.0007|
| 26 | 92.6447                | 0.0039| 0.0009|
| 27 | 92.7049                | 0.0017| 0.0006|
| 31 | 92.9549                | 0.0024| 0.0025|
| 32 | 93.0163                | 0.0015| 0.0007|
| 33 | 93.0815                | 0.0043| 0.0010|
| 34 | 93.1446                | 0.0051| 0.0005|
| 35 | 93.2025                | 0.0006| 0.0007|
| 36 | 93.2664                | 0.0022| 0.0006|
| 37 | 93.3282                | 0.0016| 0.0006|
| 38 | 93.3887                | -0.0002| 0.0003|
| 39 | 93.4558                | 0.0045| 0.0003|
| 41 | 93.5811                | 0.0051| 0.0004|
| 42 | 93.6439                | 0.0056| 0.0004|
| 43 | 93.7080                | 0.0074| 0.0006|
| 44 | 93.7701                | 0.0071| 0.0005|
| 48 | 94.0174                | 0.0051| 0.0009|
| 49 | 94.0838                | 0.0092| 0.0004|
| 50 | 94.1466                | 0.0096| 0.0002|
| 51 | 94.2089                | 0.0096| 0.0003|
| 52 | 94.2645                | 0.0028| 0.0003|
| 53 | 94.3308                | 0.0068| 0.0005|
| 56 | 94.5217                | 0.0106| 0.0007|
| 57 | 94.5786                | 0.0052| 0.0004|
| 58 | 94.6466                | 0.0109| 0.0005|
| 59 | 94.7129                | 0.0148| 0.0017|
| 65 | 95.0800                | 0.0079| 0.0006|
| 66 | 95.1399                | 0.0055| 0.0006|
| 67 | 95.2012                | 0.0044| 0.0005|
| 68 | 95.2673                | 0.0082| 0.0004|
| 69 | 95.3294                | 0.0079| 0.0008|
| 73 | 95.5839                | 0.0131| 0.0011|
| 74 | 95.6443                | 0.0111| 0.0003|
| 75 | 95.7037                | 0.0082| 0.0005|
| 80 | 96.0138                | 0.0066| 0.0009|
| 81 | 96.0797                | 0.0101| 0.0005|
| 82 | 96.1415                | 0.0096| 0.0012|
| 83 | 96.2059                | 0.0117| 0.0005|
| 84 | 96.2665                | 0.0099| 0.0004|

*BJD - 2455600
Table 5. (Continued.)

| E  | The timings of maximum\(^\ast\) | \(O - C\) | error  |
|----|----------------------------------|----------|--------|
| 85 | 96.3263                          | 0.0074   | 0.0008 |
| 86 | 96.3907                          | 0.0094   | 0.0007 |
| 87 | 96.4507                          | 0.0071   | 0.0003 |
| 88 | 96.5141                          | 0.0082   | 0.0013 |
| 89 | 96.5767                          | 0.0084   | 0.0004 |
| 90 | 96.6424                          | 0.0118   | 0.0003 |
| 91 | 96.7647                          | 0.0094   | 0.0005 |
| 92 | 97.0762                          | 0.0092   | 0.0008 |
| 93 | 97.1412                          | 0.0119   | 0.0008 |
| 94 | 97.2086                          | 0.0169   | 0.0015 |
| 95 | 97.2631                          | 0.0091   | 0.0006 |
| 96 | 97.3310                          | 0.0146   | 0.0012 |
| 97 | 97.3904                          | 0.0117   | 0.0011 |
| 98 | 97.4557                          | 0.0146   | 0.0005 |
| 99 | 97.5151                          | 0.0118   | 0.0003 |
| 100| 97.5805                          | 0.0148   | 0.0004 |
| 101| 97.6441                          | 0.0161   | 0.0005 |
| 102| 97.6968                          | 0.0064   | 0.0004 |
| 103| 98.0188                          | 0.0167   | 0.0024 |
| 104| 98.0816                          | 0.0172   | 0.0013 |
| 105| 98.1413                          | 0.0145   | 0.0007 |
| 106| 98.2044                          | 0.0153   | 0.0008 |
| 107| 98.2669                          | 0.0154   | 0.0005 |
| 108| 98.3234                          | 0.0096   | 0.0003 |
| 109| 98.3977                          | 0.0216   | 0.0014 |
| 110| 98.4545                          | 0.0161   | 0.0011 |
| 111| 98.5081                          | 0.0073   | 0.0010 |
| 112| 98.5759                          | 0.0127   | 0.0008 |
| 113| 98.6327                          | 0.0073   | 0.0003 |
| 114| 98.6976                          | 0.0098   | 0.0011 |
| 115| 98.7624                          | 0.0122   | 0.0081 |
| 116| 98.8246                          | 0.0121   | 0.0007 |
| 117| 98.8840                          | 0.0101   | 0.0011 |
| 118| 99.1398                          | 0.0156   | 0.0008 |
| 119| 99.1883                          | 0.0018   | 0.0085 |
| 120| 99.3225                          | 0.0113   | 0.0030 |
| 121| 99.3823                          | 0.0088   | 0.0014 |
| 122| 99.4515                          | 0.0156   | 0.0006 |
| 123| 99.5140                          | 0.0158   | 0.0004 |
| 124| 99.5756                          | 0.0151   | 0.0005 |
| 125| 99.6382                          | 0.0153   | 0.0003 |
| 126| 99.7031                          | 0.0179   | 0.0005 |
| 127| 100.0738                         | 0.0145   | 0.0012 |
| 128| 100.1355                         | 0.0138   | 0.0012 |
| 129| 100.2015                         | 0.0175   | 0.0005 |
| 130| 100.2652                         | 0.0189   | 0.0004 |
| 131| 100.3243                         | 0.0156   | 0.0007 |
| 132| 100.3838                         | 0.0128   | 0.0011 |
| 133| 100.4450                         | 0.0117   | 0.0005 |
| 134| 100.6386                         | 0.0182   | 0.0003 |
| 135| 100.6965                         | 0.0138   | 0.0005 |
| 136| 100.7617                         | 0.0167   | 0.0007 |
| 137| 100.8236                         | 0.0162   | 0.0009 |
| 138| 100.8832                         | 0.0135   | 0.0008 |
| 139| 100.9479                         | 0.0159   | 0.0002 |

\(\text{BJD} - 2455600\)
Table 5. (Continued.)

| E   | The timings of maximum* | O − C | error |
|-----|-------------------------|-------|-------|
| 160 | 101.0072                | 0.0128| 0.0003|
| 165 | 101.3212                | 0.0151| 0.0005|
| 166 | 101.3789                | 0.0105| 0.0004|
| 167 | 101.4425                | 0.0117| 0.0013|
| 168 | 101.5147                | 0.0216| 0.0007|
| 169 | 101.5705                | 0.0151| 0.0002|
| 170 | 101.6316                | 0.0139| 0.0002|
| 171 | 102.0040                | 0.0121| 0.0012|
| 172 | 102.0636                | 0.0094| 0.0011|
| 173 | 102.1317                | 0.0152| 0.0005|
| 174 | 102.1937                | 0.0149| 0.0007|
| 175 | 102.3143                | 0.0107| 0.0005|
| 176 | 102.3787                | 0.0128| 0.0002|
| 177 | 102.6321                | 0.0168| 0.0005|
| 178 | 102.8930                | 0.0154| 0.0003|
| 179 | 102.7587                | 0.0188| 0.0006|
| 180 | 102.8188                | 0.0166| 0.0007|
| 181 | 102.8770                | 0.0125| 0.0006|
| 182 | 102.9407                | 0.0138| 0.0003|
| 183 | 103.0038                | 0.0145| 0.0008|
| 184 | 103.3778                | 0.0145| 0.0012|
| 185 | 103.4415                | 0.0158| 0.0022|
| 186 | 103.6263                | 0.0136| 0.0011|
| 187 | 103.6883                | 0.0133| 0.0003|
| 188 | 103.7560                | 0.0186| 0.0008|
| 189 | 103.8776                | 0.0156| 0.0007|
| 190 | 103.9370                | 0.0126| 0.0006|
| 191 | 104.0043                | 0.0176| 0.0009|
| 192 | 104.3729                | 0.0121| 0.0009|
| 193 | 104.4386                | 0.0155| 0.0005|
| 194 | 104.5010                | 0.0155| 0.0005|
| 195 | 104.6293                | 0.0192| 0.0006|
| 196 | 104.6846                | 0.0121| 0.0004|
| 197 | 104.7535                | 0.0187| 0.0006|
| 198 | 104.8090                | 0.0119| 0.0004|
| 199 | 104.8672                | 0.0167| 0.0002|
| 200 | 104.9395                | 0.0177| 0.0009|
| 201 | 104.9994                | 0.0152| 0.0002|
| 202 | 105.0629                | 0.0164| 0.0005|
| 203 | 105.1244                | 0.0155| 0.0004|
| 204 | 105.1875                | 0.0164| 0.0003|
| 205 | 105.2468                | 0.0133| 0.0008|
| 206 | 105.3077                | 0.0119| 0.0010|
| 207 | 105.3742                | 0.0160| 0.0003|
| 208 | 105.6906                | 0.0207| 0.0006|
| 209 | 105.7487                | 0.0165| 0.0005|
| 210 | 105.8112                | 0.0167| 0.0006|
| 211 | 105.8663                | 0.0094| 0.0006|
| 212 | 105.9344                | 0.0152| 0.0015|
| 213 | 106.0046                | 0.0231| 0.0009|
| 214 | 106.0580                | 0.0140| 0.0011|
| 215 | 106.1221                | 0.0158| 0.0008|
| 216 | 106.1854                | 0.0168| 0.0019|
| 217 | 106.4954                | 0.0151| 0.0005|
| 218 | 106.6221                | 0.0171| 0.0003|

*BJD−2455600
Table 5. (Continued.)

| E  | The timings of maximum$^*$ | $O - C$ | error |
|----|----------------------------|--------|-------|
| 251| 106.6792                   | 0.0119 | 0.0004|
| 252| 106.7460                   | 0.0163 | 0.0004|
| 253| 106.8057                   | 0.0137 | 0.0011|
| 254| 106.8708                   | 0.0164 | 0.0013|
| 261| 107.3024                   | 0.0116 | 0.0007|
| 262| 107.3662                   | 0.0131 | 0.0006|
| 268| 107.7360                   | 0.0088 | 0.0010|
| 269| 107.8029                   | 0.0134 | 0.0004|
| 270| 107.8591                   | 0.0073 | 0.0005|
| 272| 107.9807                   | 0.0042 | 0.0008|
| 273| 108.0522                   | 0.0134 | 0.0008|
| 274| 108.1067                   | 0.0056 | 0.0005|
| 275| 108.1797                   | 0.0162 | 0.0003|
| 276| 108.2419                   | 0.0161 | 0.0012|
| 278| 108.3574                   | 0.0069 | 0.0004|
| 279| 108.4284                   | 0.0155 | 0.0009|
| 284| 108.7351                   | 0.0105 | 0.0007|
| 285| 108.7976                   | 0.0107 | 0.0004|
| 286| 108.8617                   | 0.0124 | 0.0002|
| 287| 108.9258                   | 0.0142 | 0.0009|
| 288| 108.9900                   | 0.0161 | 0.0004|
| 300| 109.7315                   | 0.0095 | 0.0021|
| 301| 109.7956                   | 0.0112 | 0.0008|
| 302| 109.8582                   | 0.0116 | 0.0008|
| 310| 110.3521                   | 0.0067 | 0.0009|
| 311| 110.4163                   | 0.0085 | 0.0006|
| 320| 110.9740                   | 0.0052 | 0.0011|
| 321| 111.0405                   | 0.0093 | 0.0007|
| 322| 111.1021                   | 0.0086 | 0.0011|
| 323| 111.1697                   | 0.0139 | 0.0009|
| 324| 111.2291                   | 0.0110 | 0.0009|
| 325| 111.2820                   | 0.0015 | 0.0006|
| 326| 111.3529                   | 0.0100 | 0.0007|
| 331| 111.6634                   | 0.0089 | 0.0004|
| 332| 111.7235                   | 0.0066 | 0.0006|
| 347| 112.6572                   | 0.0053 | 0.0008|
| 348| 112.7221                   | 0.0078 | 0.0007|
| 349| 112.7834                   | 0.0067 | 0.0004|
| 353| 113.0335                   | 0.0074 | 0.0008|
| 354| 113.0937                   | 0.0054 | 0.0004|
| 356| 113.2221                   | 0.0091 | 0.0008|
| 357| 113.2797                   | 0.0044 | 0.0007|
| 358| 113.3427                   | 0.0050 | 0.0007|
| 359| 113.4082                   | 0.0081 | 0.0008|
| 360| 113.4722                   | 0.0098 | 0.0020|
| 361| 113.5312                   | 0.0064 | 0.0005|
| 362| 113.5956                   | 0.0085 | 0.0005|
| 363| 113.6552                   | 0.0058 | 0.0005|
| 367| 113.9015                   | 0.0027 | 0.0035|
| 368| 113.9701                   | 0.0089 | 0.0005|
| 369| 114.0324                   | 0.0089 | 0.0005|
| 370| 114.0935                   | 0.0077 | 0.0004|
| 371| 114.1530                   | 0.0049 | 0.0004|
| 373| 114.2806                   | 0.0078 | 0.0009|
| 374| 114.3419                   | 0.0068 | 0.0003|

$^*$BJD$-2455600$
Table 5. (Continued.)

| E   | The timings of maximum$^*$ | $O - C$ | error |
|-----|---------------------------|--------|-------|
| 375 | 114.4033                  | 0.0058 | 0.0003|
| 376 | 114.4689                  | 0.0091 | 0.0006|
| 377 | 114.5306                  | 0.0084 | 0.0004|
| 378 | 114.5926                  | 0.0081 | 0.0004|
| 379 | 114.6569                  | 0.0100 | 0.0004|
| 380 | 114.7153                  | 0.0061 | 0.0006|
| 381 | 114.7800                  | 0.0085 | 0.0003|
| 382 | 114.8435                  | 0.0096 | 0.0002|
| 384 | 114.9694                  | 0.0109 | 0.0007|
| 385 | 115.0326                  | 0.0117 | 0.0007|
| 386 | 115.0927                  | 0.0095 | 0.0003|
| 387 | 115.1559                  | 0.0103 | 0.0010|
| 388 | 115.2147                  | 0.0068 | 0.0006|
| 389 | 115.2835                  | 0.0132 | 0.0008|
| 390 | 115.3399                  | 0.0073 | 0.0010|
| 392 | 115.4709                  | 0.0136 | 0.0010|
| 393 | 115.5332                  | 0.0136 | 0.0018|
| 392 | 115.4717                  | 0.0144 | 0.0006|
| 395 | 115.6529                  | 0.0086 | 0.0011|
| 396 | 115.7114                  | 0.0048 | 0.0016|
| 397 | 115.7713                  | 0.0023 | 0.0007|
| 398 | 115.8365                  | 0.0052 | 0.0004|
| 399 | 115.9003                  | 0.0066 | 0.0005|
| 402 | 116.0850                  | 0.0043 | 0.0005|
| 404 | 116.2054                  | 0.0001 | 0.0035|
| 405 | 116.2673                  | −0.0003| 0.0006|
| 406 | 116.3333                  | 0.0032 | 0.0007|
| 407 | 116.4015                  | 0.0091 | 0.0004|
| 408 | 116.4596                  | 0.0049 | 0.0007|
| 409 | 116.5183                  | 0.0013 | 0.0006|
| 410 | 116.5866                  | 0.0072 | 0.0008|
| 411 | 116.6450                  | 0.0033 | 0.0006|
| 412 | 116.7064                  | 0.0023 | 0.0007|
| 413 | 116.7785                  | 0.0120 | 0.0007|
| 414 | 116.8341                  | 0.0054 | 0.0006|
| 415 | 116.9003                  | 0.0092 | 0.0004|
| 419 | 117.1423                  | 0.0019 | 0.0006|
| 420 | 117.2070                  | 0.0042 | 0.0005|
| 421 | 117.2664                  | 0.0012 | 0.0009|
| 422 | 117.3272                  | −0.0003| 0.0017|
| 423 | 117.3932                  | 0.0034 | 0.0006|
| 425 | 117.5156                  | 0.0011 | 0.0029|
| 426 | 117.5742                  | −0.0027| 0.0005|
| 427 | 117.6438                  | 0.0046 | 0.0008|
| 428 | 117.6991                  | −0.0024| 0.0004|
| 429 | 117.7643                  | 0.0004 | 0.0005|
| 428 | 117.6994                  | −0.0021| 0.0003|
| 431 | 117.9065                  | 0.0179 | 0.0012|
| 433 | 118.0121                  | −0.0011| 0.0038|
| 434 | 118.0766                  | 0.0010 | 0.0009|
| 435 | 118.1405                  | 0.0026 | 0.0004|
| 436 | 118.1950                  | −0.0052| 0.0007|
| 438 | 118.3208                  | −0.0042| 0.0003|
| 439 | 118.3887                  | 0.0014 | 0.0004|
| 442 | 118.5750                  | 0.0007 | 0.0009|

$^*$BJD−2455600
Table 5. (Continued.)

| E  | The timings of maximum* | $O - C$ | error |
|----|-------------------------|--------|-------|
| 443| 118.6307                | -0.0059| 0.0006|
| 444| 118.6970                | -0.0020| 0.0005|
| 445| 118.7583                | -0.0030| 0.0005|
| 446| 118.8207                | -0.0029| 0.0007|
| 447| 118.8825                | -0.0035| 0.0005|
| 448| 118.9472                | -0.0011| 0.0009|
| 449| 119.0081                | -0.0026| 0.0006|
| 450| 119.0679                | -0.0051| 0.0007|
| 451| 119.1281                | -0.0083| 0.0020|
| 452| 119.3818                | -0.0029| 0.0009|
| 453| 119.4451                | -0.0019| 0.0021|
| 454| 119.6273                | -0.0068| 0.0012|
| 455| 120.3179                | -0.0019| 0.0016|
| 456| 120.3768                | -0.0054| 0.0014|
| 457| 120.4399                | -0.0046| 0.0004|
| 458| 120.6285                | -0.0030| 0.0007|
| 459| 120.6791                | -0.0147| 0.0006|
| 460| 120.7492                | -0.0070| 0.0003|
| 461| 120.8101                | -0.0084| 0.0007|
| 462| 120.8775                | -0.0033| 0.0006|
| 463| 120.9259                | -0.0173| 0.0007|
| 464| 121.3760                | -0.0035| 0.0014|
| 465| 121.4915                | -0.0127| 0.0010|
| 466| 121.6760                | -0.0153| 0.0002|
| 467| 121.7374                | -0.0162| 0.0015|
| 468| 121.7993                | -0.0167| 0.0004|

*BJD−2455600.
Table 6. Log of the maximum timings of negative superhumps during supercycle 2011 S2

| E | The timings of maximum $^\ast$ | $O - C$ | error |
|---|-------------------------------|--------|-------|
| 0 | 142.3454                      | -0.0006| 0.0005|
| 1 | 142.4068                      | -0.0016| 0.0004|
| 2 | 142.4684                      | -0.0023| 0.0009|
| 3 | 142.5290                      | -0.0040| 0.0007|
| 10 | 142.9677                      | -0.0017| 0.0012|
| 11 | 143.0307                      | -0.0011| 0.0011|
| 13 | 143.1522                      | -0.0042| 0.0019|
| 14 | 143.2161                      | -0.0026| 0.0010|
| 15 | 143.2793                      | -0.0018| 0.0014|
| 16 | 143.3413                      | -0.0021| 0.0008|
| 17 | 143.4055                      | -0.0002| 0.0006|
| 18 | 143.4689                      | 0.0008 | 0.0006|
| 19 | 143.5318                      | 0.0014 | 0.0004|
| 20 | 143.5954                      | 0.0026 | 0.0008|
| 21 | 143.6527                      | -0.0024| 0.0005|
| 23 | 143.7788                      | -0.0010| 0.0005|
| 24 | 143.8478                      | 0.0056 | 0.0006|
| 27 | 144.0266                      | -0.0026| 0.0014|
| 28 | 144.0810                      | -0.0105| 0.0013|
| 29 | 144.1471                      | -0.0068| 0.0020|
| 30 | 144.2141                      | -0.0020| 0.0006|
| 31 | 144.2813                      | 0.0028 | 0.0008|
| 32 | 144.3421                      | 0.0012 | 0.0006|
| 33 | 144.4076                      | 0.0044 | 0.0005|
| 34 | 144.4658                      | 0.0003 | 0.0026|
| 35 | 144.5267                      | -0.0011| 0.0003|
| 36 | 144.5886                      | -0.0016| 0.0005|
| 37 | 144.6576                      | 0.0051 | 0.0005|
| 38 | 144.7142                      | -0.0007| 0.0013|
| 39 | 144.7790                      | 0.0018 | 0.0007|
| 40 | 144.8413                      | 0.0017 | 0.0004|
| 42 | 144.9687                      | 0.0044 | 0.0013|
| 43 | 145.0284                      | 0.0018 | 0.0009|
| 44 | 145.0887                      | -0.0002| 0.0008|
| 45 | 145.1539                      | 0.0026 | 0.0007|
| 46 | 145.2155                      | 0.0019 | 0.0007|
| 47 | 145.2783                      | 0.0023 | 0.0013|
| 48 | 145.3405                      | 0.0022 | 0.0009|
| 49 | 145.3999                      | -0.0007| 0.0008|
| 50 | 145.4638                      | 0.0009 | 0.0011|
| 51 | 145.5249                      | -0.0004| 0.0010|
| 53 | 145.6530                      | 0.0030 | 0.0008|
| 54 | 145.7172                      | 0.0049 | 0.0006|
| 55 | 145.7802                      | 0.0055 | 0.0009|
| 56 | 145.8386                      | 0.0016 | 0.0008|
| 57 | 145.9026                      | 0.0033 | 0.0003|
| 61 | 146.1581                      | 0.0094 | 0.0012|
| 62 | 146.2145                      | 0.0035 | 0.0006|
| 63 | 146.2764                      | 0.0031 | 0.0005|
| 64 | 146.3406                      | 0.0049 | 0.0008|
| 65 | 146.3995                      | 0.0015 | 0.0006|
| 66 | 146.4646                      | 0.0043 | 0.0008|
| 67 | 146.5278                      | 0.0051 | 0.0005|
| 68 | 146.5906                      | 0.0056 | 0.0018|
| 70 | 146.7147                      | 0.0049 | 0.0007|

$^\ast$BJD$-2455600$
Table 6. (Continued.)

|   | The timings of maximum∗ | O−C    | error   |
|---|-------------------------|--------|---------|
| 72| 146.8375                | 0.0031 | 0.0003  |
| 73| 146.9020                | 0.0052 | 0.0011  |
| 74| 146.9617                | 0.0026 | 0.0004  |
| 75| 147.0288                | 0.0073 | 0.0003  |
| 76| 147.0829                | −0.0009| 0.0008  |
| 77| 147.1530                | 0.0069 | 0.0004  |
| 78| 147.2076                | −0.0008| 0.0007  |
| 79| 147.2728                | 0.0020 | 0.0004  |
| 80| 147.3350                | 0.0019 | 0.0005  |
| 81| 147.3984                | 0.0029 | 0.0006  |
| 82| 147.4574                | −0.0004| 0.0003  |
| 83| 147.6501                | 0.0052 | 0.0006  |
| 86| 147.7097                | 0.0025 | 0.0018  |
| 87| 147.7691                | −0.0004| 0.0002  |
| 88| 147.8363                | 0.0045 | 0.0005  |
| 91| 148.0200                | 0.0012 | 0.0006  |
| 92| 148.0854                | 0.0042 | 0.0006  |
| 93| 148.1477                | 0.0042 | 0.0005  |
| 94| 148.2075                | 0.0017 | 0.0004  |
| 95| 148.2732                | 0.0050 | 0.0004  |
| 96| 148.3331                | 0.0026 | 0.0006  |
| 97| 148.3977                | 0.0048 | 0.0003  |
| 98| 148.4612                | 0.0060 | 0.0005  |
| 101|148.6461                | 0.0039 | 0.0004  |
| 102|148.7110                | 0.0064 | 0.0005  |
| 104|148.8320                | 0.0027 | 0.0006  |
| 105|148.8975                | 0.0059 | 0.0004  |
| 106|148.9561                | 0.0022 | 0.0007  |
| 107|149.0177                | 0.0014 | 0.0016  |
| 108|149.0844                | 0.0057 | 0.0004  |
| 109|149.1472                | 0.0062 | 0.0003  |
| 110|149.2085                | 0.0052 | 0.0004  |
| 111|149.2722                | 0.0065 | 0.0007  |
| 112|149.3324                | 0.0045 | 0.0004  |
| 113|149.3925                | 0.0022 | 0.0013  |
| 114|149.4613                | 0.0086 | 0.0003  |
| 115|149.5181                | 0.0031 | 0.0009  |
| 116|149.5819                | 0.0046 | 0.0003  |
| 117|149.6458                | 0.0061 | 0.0005  |
| 118|149.7082                | 0.0062 | 0.0010  |
| 127|150.2692                | 0.0061 | 0.0008  |
| 128|150.3324                | 0.0070 | 0.0006  |
| 129|150.3943                | 0.0066 | 0.0013  |
| 130|150.4555                | 0.0055 | 0.0005  |
| 131|150.5220                | 0.0096 | 0.0003  |
| 132|150.5809                | 0.0062 | 0.0005  |
| 133|150.6438                | 0.0067 | 0.0005  |
| 134|150.7072                | 0.0077 | 0.0006  |
| 135|150.7699                | 0.0081 | 0.0004  |
| 138|150.9554                | 0.0066 | 0.0004  |
| 139|151.0228                | 0.0117 | 0.0006  |
| 140|151.0786                | 0.0051 | 0.0005  |
| 141|151.1473                | 0.0115 | 0.0008  |
| 142|151.2041                | 0.0060 | 0.0007  |
| 143|151.2635                | 0.0031 | 0.0006  |

∗BJD−2455600
| E   | The timings of maximum$^*$  | $O - C$  | error |
|-----|----------------------------|---------|-------|
| 145 | 151.3880                   | 0.0028  | 0.0018|
| 146 | 151.4540                   | 0.0065  | 0.0006|
| 147 | 151.5133                   | 0.0035  | 0.0009|
| 148 | 151.5875                   | 0.0153  | 0.0007|
| 155 | 152.0135                   | 0.0049  | 0.0004|
| 156 | 152.0766                   | 0.0057  | 0.0005|
| 157 | 152.1396                   | 0.0064  | 0.0006|
| 158 | 152.2037                   | 0.0081  | 0.0005|
| 159 | 152.2618                   | 0.0039  | 0.0011|
| 160 | 152.3226                   | 0.0024  | 0.0014|
| 161 | 152.3915                   | 0.0089  | 0.0005|
| 162 | 152.4547                   | 0.0097  | 0.0011|
| 163 | 152.5160                   | 0.0087  | 0.0005|
| 164 | 152.5755                   | 0.0059  | 0.0005|
| 165 | 152.6365                   | 0.0045  | 0.0006|
| 166 | 152.6987                   | 0.0045  | 0.0003|
| 167 | 152.7658                   | 0.0092  | 0.0005|
| 168 | 152.8256                   | 0.0067  | 0.0006|
| 169 | 152.8937                   | 0.0124  | 0.0007|
| 170 | 152.9515                   | 0.0079  | 0.0006|
| 171 | 153.0137                   | 0.0077  | 0.0015|
| 172 | 153.0902                   | 0.0219  | 0.0021|
| 174 | 153.2061                   | 0.0131  | 0.0010|
| 176 | 153.3277                   | 0.0100  | 0.0009|
| 177 | 153.3902                   | 0.0102  | 0.0011|
| 178 | 153.4479                   | 0.0055  | 0.0006|
| 181 | 153.6401                   | 0.0108  | 0.0006|
| 182 | 153.7014                   | 0.0097  | 0.0008|
| 183 | 153.7580                   | 0.0039  | 0.0004|
| 184 | 153.8180                   | 0.0016  | 0.0003|
| 185 | 153.8802                   | 0.0015  | 0.0004|
| 187 | 154.0084                   | 0.0050  | 0.0012|
| 194 | 154.4416                   | 0.0018  | 0.0021|
| 195 | 154.5049                   | 0.0028  | 0.0005|
| 196 | 154.5699                   | 0.0055  | 0.0006|
| 197 | 154.6327                   | 0.0059  | 0.0007|
| 198 | 154.6929                   | 0.0037  | 0.0009|
| 202 | 154.9366                   | −0.0018 | 0.0023|
| 203 | 155.0050                   | 0.0042  | 0.0005|
| 204 | 155.0681                   | 0.0050  | 0.0007|
| 205 | 155.1314                   | 0.0059  | 0.0003|
| 206 | 155.1909                   | 0.0030  | 0.0004|
| 207 | 155.2549                   | 0.0048  | 0.0004|
| 208 | 155.3143                   | 0.0018  | 0.0006|
| 209 | 155.3789                   | 0.0041  | 0.0006|
| 210 | 155.4403                   | 0.0031  | 0.0006|
| 211 | 155.5043                   | 0.0047  | 0.0004|
| 212 | 155.5666                   | 0.0048  | 0.0009|
| 213 | 155.6312                   | 0.0070  | 0.0005|
| 219 | 156.0015                   | 0.0032  | 0.0005|
| 220 | 156.0659                   | 0.0053  | 0.0005|
| 221 | 156.1251                   | 0.0022  | 0.0005|
| 222 | 156.1906                   | 0.0054  | 0.0006|
| 223 | 156.2491                   | 0.0015  | 0.0005|
| 227 | 156.5012                   | 0.0043  | 0.0014|

$^*$BJD−2455600
Table 6. (Continued.)

| E  | The timings of maximum | $O - C$ | error |
|----|------------------------|---------|-------|
| 228 | 156.5634               | 0.0041  | 0.0003|
| 235 | 156.9970               | 0.0013  | 0.0005|
| 236 | 157.0610               | 0.0030  | 0.0007|
| 237 | 157.1234               | 0.0031  | 0.0002|
| 238 | 157.1854               | 0.0028  | 0.0003|
| 239 | 157.2550               | 0.0099  | 0.0207|
| 240 | 157.3143               | 0.0069  | 0.0007|
| 241 | 157.3705               | 0.0008  | 0.0004|
| 242 | 157.4323               | 0.0003  | 0.0004|
| 243 | 157.4955               | 0.0011  | 0.0006|
| 244 | 157.5601               | 0.0034  | 0.0009|
| 245 | 157.6205               | 0.0014  | 0.0009|
| 252 | 158.0606               | 0.0052  | 0.0006|
| 253 | 158.1237               | 0.0060  | 0.0007|
| 254 | 158.1770               | −0.0031 | 0.0008|
| 259 | 158.4893               | −0.0025 | 0.0009|
| 260 | 158.5545               | 0.0004  | 0.0010|
| 261 | 158.6128               | −0.0037 | 0.0005|
| 262 | 158.6776               | −0.0013 | 0.0005|
| 268 | 159.0541               | 0.0013  | 0.0004|
| 269 | 159.1116               | −0.0036 | 0.0009|
| 288 | 160.2913               | −0.0084 | 0.0005|
| 289 | 160.3576               | −0.0043 | 0.0006|
| 291 | 160.4815               | −0.0051 | 0.0003|
| 292 | 160.5446               | −0.0044 | 0.0006|
| 293 | 160.6096               | −0.0018 | 0.0005|
| 305 | 161.3556               | −0.0038 | 0.0035|
| 306 | 161.4259               | 0.0041  | 0.0022|
| 307 | 161.4726               | −0.0115 | 0.0011|
| 308 | 161.5416               | −0.0048 | 0.0013|
| 309 | 161.5983               | −0.0105 | 0.0010|
| 317 | 162.1020               | −0.0055 | 0.0011|
| 318 | 162.1712               | 0.0014  | 0.0020|
| 319 | 162.2307               | −0.0015 | 0.0050|
| 321 | 162.3518               | −0.0050 | 0.0013|
| 322 | 162.4054               | −0.0137 | 0.0014|
| 324 | 162.5348               | −0.0090 | 0.0008|
| 325 | 162.5992               | −0.0070 | 0.0006|
| 331 | 162.9636               | −0.0166 | 0.0028|
| 332 | 163.0307               | −0.0118 | 0.0015|
| 333 | 163.0867               | −0.0182 | 0.0012|
| 334 | 163.1572               | −0.0100 | 0.0018|
| 347 | 163.9683               | −0.0093 | 0.0008|
| 348 | 164.0291               | −0.0109 | 0.0005|
| 349 | 164.0899               | −0.0124 | 0.0009|
| 350 | 164.1563               | −0.0083 | 0.0006|
| 351 | 164.2141               | −0.0128 | 0.0006|
| 352 | 164.2787               | −0.0107 | 0.0011|
| 353 | 164.3354               | −0.0163 | 0.0021|
| 354 | 164.4021               | −0.0119 | 0.0008|
| 355 | 164.4618               | −0.0145 | 0.0017|
| 356 | 164.5239               | −0.0148 | 0.0016|
| 357 | 164.5894               | −0.0116 | 0.0008|
| 364 | 165.0257               | −0.0117 | 0.0073|
| 366 | 165.1510               | −0.0111 | 0.0005|

$^*$BJD − 2455600
| E  | The timings of maximum* | $O - C$   | error  |
|----|-------------------------|----------|--------|
| 367| 165.2098                | -0.0146  | 0.0004 |
| 368| 165.2776                | -0.0091  | 0.0015 |
| 369| 165.3414                | -0.0077  | 0.0005 |
| 370| 165.4011                | -0.0104  | 0.0005 |
| 415| 168.1891                | -0.0275  | 0.0009 |
| 416| 168.2492                | -0.0298  | 0.0007 |
| 417| 168.3176                | -0.0238  | 0.0017 |
| 418| 168.3796                | -0.0241  | 0.0020 |
| 419| 168.4389                | -0.0271  | 0.0007 |
| 420| 168.5040                | -0.0244  | 0.0008 |
| 421| 168.5636                | -0.0271  | 0.0006 |
| 435| 169.4300                | -0.0334  | 0.0028 |
| 436| 169.4970                | -0.0288  | 0.0017 |
| 437| 169.5568                | -0.0313  | 0.0014 |
| 451| 170.4902                | -0.0330  | 0.0014 |
| 452| 170.5532                | -0.0323  | 0.0010 |
| 460| 170.9884                | -0.0335  | 0.0014 |
| 463| 171.1720                | -0.0370  | 0.0016 |
| 466| 171.3632                | -0.0328  | 0.0009 |
| 467| 171.4263                | -0.0318  | 0.0014 |
| 468| 171.4883                | -0.0324  | 0.0010 |
| 469| 171.5508                | -0.0322  | 0.0015 |

*BJD−2455600.
Table 7. Log of the maximum timings of negative superhumps during supercycle 2011 S3

| E  | The timings of maximum$^*$ | $O - C$ | error |
|----|---------------------------|---------|-------|
| 0  | 191.4019                  | −0.0031 | 0.0007|
| 1  | 191.4632                  | −0.0041 | 0.0008|
| 2  | 191.5268                  | −0.0028 | 0.0010|
| 14 | 192.2708                  | −0.0065 | 0.0049|
| 15 | 192.3389                  | −0.0007 | 0.0006|
| 16 | 192.4021                  | 0.0003  | 0.0008|
| 17 | 192.4646                  | 0.0004  | 0.0006|
| 31 | 193.3354                  | −0.0010 | 0.0004|
| 32 | 193.4005                  | 0.0017  | 0.0005|
| 33 | 193.4640                  | 0.0030  | 0.0009|
| 34 | 193.5271                  | 0.0037  | 0.0018|
| 48 | 194.4007                  | 0.0051  | 0.0012|
| 49 | 194.4621                  | 0.0042  | 0.0008|
| 50 | 194.5210                  | 0.0008  | 0.0009|
| 51 | 194.5859                  | 0.0033  | 0.0006|
| 57 | 194.9616                  | 0.0052  | 0.0008|
| 58 | 195.0240                  | 0.0053  | 0.0014|
| 59 | 195.0906                  | 0.0096  | 0.0010|
| 73 | 195.9585                  | 0.0052  | 0.0010|
| 74 | 196.0199                  | 0.0044  | 0.0008|
| 76 | 196.1391                  | −0.0011 | 0.0007|
| 95 | 197.3279                  | 0.0039  | 0.0007|
| 96 | 197.3918                  | 0.0055  | 0.0008|
| 97 | 197.4532                  | 0.0046  | 0.0018|
| 111| 198.3312                  | 0.0104  | 0.0008|
| 112| 198.3932                  | 0.0100  | 0.0011|
| 123| 199.0810                  | 0.0124  | 0.0015|
| 124| 199.1380                  | 0.0072  | 0.0008|
| 127| 199.3259                  | 0.0081  | 0.0010|
| 128| 199.3872                  | 0.0072  | 0.0016|
| 138| 200.0147                  | 0.0116  | 0.0021|
| 139| 200.0641                  | −0.0013 | 0.0011|
| 140| 200.1353                  | 0.0076  | 0.0012|
| 143| 200.3277                  | 0.0131  | 0.0009|
| 144| 200.3891                  | 0.0122  | 0.0006|
| 145| 200.4427                  | 0.0034  | 0.0016|
| 146| 200.5142                  | 0.0127  | 0.0007|
| 154| 201.0088                  | 0.0088  | 0.0011|
| 155| 201.0771                  | 0.0148  | 0.0017|
| 156| 201.1347                  | 0.0102  | 0.0007|
| 159| 201.3233                  | 0.0118  | 0.0009|
| 160| 201.3796                  | 0.0058  | 0.0012|
| 170| 202.0009                  | 0.0040  | 0.0011|
| 171| 202.0703                  | 0.0111  | 0.0013|
| 172| 202.1287                  | 0.0073  | 0.0004|
| 177| 202.4423                  | 0.0093  | 0.0010|
| 178| 202.5016                  | 0.0064  | 0.0006|
| 179| 202.5650                  | 0.0074  | 0.0006|
| 193| 203.4386                  | 0.0088  | 0.0005|
| 209| 204.4303                  | 0.0036  | 0.0021|
| 210| 204.4949                  | 0.0059  | 0.0008|
| 223| 205.3069                  | 0.0079  | 0.0008|
| 224| 205.3685                  | 0.0072  | 0.0010|
| 225| 205.4389                  | 0.0153  | 0.0015|
| 234| 205.9934                  | 0.0090  | 0.0011|

$^*$BJD−2455600
Table 7. (Continued.)

| E    | The timings of maximum* | $O - C$ | error |
|------|-------------------------|--------|-------|
| 235  | 206.0528                | 0.0061 | 0.0013|
| 239  | 206.3033                | 0.0074 | 0.0021|
| 240  | 206.3672                | 0.0090 | 0.0008|
| 255  | 207.2995                | 0.0067 | 0.0015|
| 256  | 207.3633                | 0.0083 | 0.0011|
| 257  | 207.4256                | 0.0083 | 0.0005|
| 258  | 207.4865                | 0.0068 | 0.0009|
| 271  | 208.2957                | 0.0060 | 0.0017|
| 272  | 208.3603                | 0.0084 | 0.0016|
| 288  | 209.3500                | 0.0011 | 0.0010|
| 321  | 211.3999                | −0.0050| 0.0006|
| 322  | 211.4662                | −0.0010| 0.0007|
| 323  | 211.5279                | −0.0016| 0.0015|
| 337  | 212.4022                | 0.0004 | 0.0008|
| 338  | 212.4617                | −0.0024| 0.0005|
| 367  | 214.2770                | 0.0061 | 0.0039|
| 368  | 214.3247                | −0.0085| 0.0012|
| 369  | 214.3983                | 0.0027 | 0.0014|
| 370  | 214.4530                | −0.0049| 0.0008|
| 371  | 214.5138                | −0.0063| 0.0011|
| 380  | 215.0692                | −0.0117| 0.0011|
| 411  | 216.9987                | −0.0136| 0.0014|
| 428  | 218.0501                | −0.0214| 0.0019|
| 433  | 218.3678                | −0.0153| 0.0017|
| 464  | 220.2951                | −0.0194| 0.0027|
| 480  | 221.3068                | −0.0046| 0.0014|
| 497  | 222.3590                | −0.0116| 0.0019|

*BJS − 2455600.
Table 8. Log of the maximum timings of negative superhumps during 2012 S1

| E  | The timings of maximum$^*$ | O − C | error   |
|----|---------------------------|-------|---------|
| 0  | 0.6919                    | 0.0119| 0.0008  |
| 1  | 0.7502                    | 0.0080| 0.0009  |
| 16 | 1.6849                    | 0.0092| 0.0009  |
| 17 | 1.7517                    | 0.0138| 0.0004  |
| 31 | 2.6249                    | 0.0158| 0.0010  |
| 32 | 2.6840                    | 0.0126| 0.0006  |
| 33 | 2.7472                    | 0.0136| 0.0010  |
| 72 | 5.1751                    | 0.0145| 0.0016  |
| 73 | 5.2297                    | 0.0069| 0.0006  |
| 74 | 5.2975                    | 0.0125| 0.0006  |
| 89 | 6.2314                    | 0.0129| 0.0006  |
| 106| 7.2932                    | 0.0168| 0.0008  |
| 107| 7.3574                    | 0.0188| 0.0005  |
| 139| 10.5994                   | 0.0248| 0.0009  |
| 160| 10.6621                   | 0.0253| 0.0007  |
| 161| 10.7249                   | 0.0259| 0.0008  |
| 162| 10.7794                   | 0.0182| 0.0024  |
| 185| 12.2157                   | 0.0231| 0.0004  |
| 187| 12.3359                   | 0.0189| 0.0004  |
| 201| 13.2023                   | 0.0140| 0.0005  |
| 202| 13.2718                   | 0.0214| 0.0010  |
| 224| 14.6377                   | 0.0182| 0.0013  |
| 225| 14.7083                   | 0.0265| 0.0006  |
| 226| 14.7560                   | 0.0121| 0.0006  |
| 240| 15.6290                   | 0.0138| 0.0008  |
| 241| 15.6958                   | 0.0184| 0.0007  |
| 242| 15.7551                   | 0.0155| 0.0008  |
| 256| 16.6266                   | 0.0158| 0.0005  |
| 257| 16.6822                   | 0.0091| 0.0013  |
| 258| 16.7496                   | 0.0143| 0.0007  |
| 271| 17.5624                   | 0.0181| 0.0010  |
| 273| 17.6876                   | 0.0188| 0.0006  |
| 274| 17.7460                   | 0.0150| 0.0007  |
| 287| 18.5538                   | 0.0138| 0.0014  |
| 288| 18.6211                   | 0.0188| 0.0026  |
| 289| 18.6748                   | 0.0103| 0.0007  |
| 290| 18.7524                   | 0.0257| 0.0010  |
| 306| 19.7387                   | 0.0164| 0.0007  |
| 313| 20.1770                   | 0.0190| 0.0007  |
| 314| 20.2409                   | 0.0206| 0.0004  |
| 330| 21.2310                   | 0.0151| 0.0005  |
| 331| 21.2906                   | 0.0125| 0.0005  |
| 335| 21.5473                   | 0.0203| 0.0012  |
| 336| 21.6015                   | 0.0122| 0.0008  |
| 337| 21.6687                   | 0.0172| 0.0003  |
| 338| 21.7274                   | 0.0137| 0.0007  |
| 347| 22.2821                   | 0.0082| 0.0004  |
| 348| 22.3473                   | 0.0113| 0.0003  |
| 352| 22.5939                   | 0.0089| 0.0012  |
| 353| 22.6537                   | 0.0065| 0.0007  |
| 354| 22.7152                   | 0.0058| 0.0008  |
| 368| 23.5880                   | 0.0074| 0.0019  |
| 369| 23.6587                   | 0.0158| 0.0008  |
| 370| 23.7115                   | 0.0064| 0.0008  |
| 382| 24.4623                   | 0.0104| 0.0020  |

$^*$BJD−2455900
| E  | The timings of maximum* | $O - C$  | Error  |
|----|-------------------------|----------|--------|
| 383| 24.5219                 | 0.0078   | 0.0054 |
| 402| 25.7031                 | 0.0067   | 0.0005 |
| 403| 25.7624                 | 0.0037   | 0.0006 |

*BJD−2455900.
Table 9. Log of the maximum timings of negative superhumps during supercycle S2

| E | The timings of maximum$^*$ | $O - C$ | error |
|---|--------------------------|--------|-------|
| 0 | 43.5669 | -0.0071 | 0.0004 |
| 1 | 43.6257 | -0.0007 | 0.0007 |
| 2 | 43.6850 | -0.0037 | 0.0003 |
| 3 | 43.7526 | 0.0015 | 0.0004 |
| 8 | 44.0618 | -0.0010 | 0.0008 |
| 9 | 44.1197 | -0.0055 | 0.0004 |
| 10 | 44.1835 | -0.0041 | 0.0008 |
| 11 | 44.2654 | 0.0154 | 0.0017 |
| 12 | 44.3027 | -0.0096 | 0.0006 |
| 17 | 44.6160 | -0.0081 | 0.0006 |
| 18 | 44.6802 | -0.0063 | 0.0005 |
| 19 | 44.7437 | -0.0051 | 0.0003 |
| 20 | 44.8049 | -0.0064 | 0.0003 |
| 21 | 44.8697 | -0.0039 | 0.0003 |
| 22 | 44.9345 | -0.0015 | 0.0003 |
| 24 | 45.0607 | 0.0000 | 0.0008 |
| 35 | 45.7450 | -0.0016 | 0.0010 |
| 36 | 45.8011 | -0.0079 | 0.0007 |
| 37 | 45.8693 | -0.0021 | 0.0012 |
| 38 | 45.9286 | -0.0052 | 0.0011 |
| 39 | 45.9926 | -0.0035 | 0.0006 |
| 45 | 46.3727 | 0.0024 | 0.0011 |
| 46 | 46.4400 | 0.0074 | 0.0009 |
| 47 | 46.4986 | 0.0036 | 0.0005 |
| 50 | 46.6838 | 0.0017 | 0.0007 |
| 52 | 46.8100 | 0.0032 | 0.0004 |
| 53 | 46.8625 | -0.0067 | 0.0010 |
| 54 | 46.9418 | 0.0102 | 0.0011 |
| 55 | 46.9935 | -0.0004 | 0.0006 |
| 67 | 47.7472 | 0.0049 | 0.0007 |
| 68 | 47.8111 | 0.0065 | 0.0004 |
| 69 | 47.8683 | 0.0013 | 0.0003 |
| 70 | 47.9341 | 0.0048 | 0.0005 |
| 71 | 47.9953 | 0.0036 | 0.0011 |
| 82 | 48.6836 | 0.0059 | 0.0006 |
| 83 | 48.7411 | 0.0010 | 0.0005 |
| 114 | 50.6774 | 0.0041 | 0.0008 |
| 115 | 50.7451 | 0.0095 | 0.0020 |
| 137 | 52.1184 | 0.0108 | 0.0006 |
| 138 | 52.1761 | 0.0061 | 0.0005 |
| 146 | 52.6694 | 0.0006 | 0.0031 |
| 147 | 52.7411 | 0.0099 | 0.0002 |
| 149 | 52.8667 | 0.0107 | 0.0005 |
| 150 | 52.9204 | 0.0021 | 0.0043 |
| 154 | 53.1815 | 0.0138 | 0.0004 |
| 155 | 53.2298 | -0.0003 | 0.0007 |
| 166 | 53.9270 | 0.0109 | 0.0006 |
| 167 | 53.9913 | 0.0129 | 0.0004 |
| 173 | 54.3571 | 0.0045 | 0.0009 |
| 174 | 54.4239 | 0.0089 | 0.0030 |
| 175 | 54.4871 | 0.0097 | 0.0006 |
| 177 | 54.6118 | 0.0098 | 0.0004 |
| 178 | 54.6730 | 0.0086 | 0.0005 |
| 187 | 55.2342 | 0.0085 | 0.0005 |
| 188 | 55.2925 | 0.0045 | 0.0004 |

$^*$BJD−2455900
| E  | The timings of maximum | $O - C$  | error |
|----|------------------------|-----------|-------|
| 189| 55.3991                | 0.0087    | 0.0009|
| 190| 55.4233                | 0.0105    | 0.0006|
| 191| 55.4885                | 0.0133    | 0.0008|
| 192| 55.5500                | 0.0125    | 0.0008|
| 193| 55.6116                | 0.0118    | 0.0011|
| 195| 55.7398                | 0.0152    | 0.0005|
| 196| 55.7995                | 0.0126    | 0.0004|
| 197| 55.8576                | 0.0083    | 0.0009|
| 198| 55.9147                | 0.0030    | 0.0004|
| 199| 55.9842                | 0.0102    | 0.0006|
| 200| 56.0465                | 0.0101    | 0.0005|
| 210| 56.6596                | −0.0004   | 0.0007|
| 211| 56.7285                | 0.0061    | 0.0002|
| 212| 56.7908                | 0.0061    | 0.0014|
| 213| 56.8518                | 0.0047    | 0.0011|
| 218| 57.1558                | −0.0031   | 0.0010|
| 219| 57.2291                | 0.0078    | 0.0006|
| 220| 57.2899                | 0.0062    | 0.0011|
| 221| 57.3534                | 0.0074    | 0.0006|
| 222| 57.4749                | 0.0041    | 0.0006|
| 224| 57.5327                | −0.0003   | 0.0006|
| 226| 57.6528                | −0.0050   | 0.0014|
| 228| 57.7883                | 0.0058    | 0.0009|
| 229| 57.8492                | 0.0043    | 0.0004|
| 230| 57.9130                | 0.0057    | 0.0032|
| 231| 57.9782                | 0.0086    | 0.0004|
| 232| 58.0582                | 0.0263    | 0.0052|
| 234| 58.1693                | 0.0126    | 0.0019|
| 235| 58.2270                | 0.0079    | 0.0007|
| 236| 58.2897                | 0.0083    | 0.0015|
| 237| 58.3511                | 0.0073    | 0.0012|
| 238| 58.4122                | 0.0060    | 0.0006|
| 239| 58.4766                | 0.0081    | 0.0004|
| 240| 58.5414                | 0.0106    | 0.0005|
| 241| 58.6007                | 0.0075    | 0.0007|
| 242| 58.6623                | 0.0067    | 0.0003|
| 245| 58.8461                | 0.0034    | 0.0003|
| 246| 58.9127                | 0.0076    | 0.0004|
| 247| 58.9789                | 0.0115    | 0.0006|
| 248| 59.0372                | 0.0074    | 0.0006|
| 250| 59.1678                | 0.0133    | 0.0011|
| 251| 59.2252                | 0.0084    | 0.0006|
| 252| 59.2854                | 0.0061    | 0.0010|
| 254| 59.4140                | 0.0100    | 0.0005|
| 255| 59.4742                | 0.0079    | 0.0014|
| 256| 59.5408                | 0.0122    | 0.0003|
| 257| 59.6029                | 0.0119    | 0.0009|
| 258| 59.6563                | 0.0029    | 0.0008|
| 259| 59.7312                | 0.0155    | 0.0006|
| 260| 59.7876                | 0.0094    | 0.0008|
| 261| 59.8469                | 0.0064    | 0.0005|
| 262| 59.9110                | 0.0082    | 0.0007|
| 263| 59.9791                | 0.0139    | 0.0005|
| 266| 60.1653                | 0.0130    | 0.0011|
| 267| 60.2244                | 0.0097    | 0.0010|

*BJD − 2455000
Table 9. (Continued.)
The timings of maximum - BJ D 24 55 900

| E  | The timings of maximum | O - C  | error  |
|----|------------------------|--------|--------|
| 268| 60.2827                | 0.0057 | 0.0006 |
| 269| 60.3517                | 0.0133 | 0.0004 |
| 272| 60.5384                | 0.0120 | 0.0007 |
| 273| 60.5982                | 0.0093 | 0.0004 |
| 274| 60.6600                | 0.0089 | 0.0022 |
| 275| 60.7216                | 0.0081 | 0.0007 |
| 276| 60.7866                | 0.0107 | 0.0003 |
| 277| 60.8515                | 0.0132 | 0.0004 |
| 279| 60.9712                | 0.0081 | 0.0003 |
| 280| 61.0373                | 0.0119 | 0.0003 |
| 284| 61.2839                | 0.0090 | 0.0012 |
| 300| 62.2835                | 0.0109 | 0.0012 |
| 301| 62.3517                | 0.0167 | 0.0007 |
| 303| 62.4682                | 0.0086 | 0.0016 |
| 304| 62.5336                | 0.0116 | 0.0016 |
| 305| 62.5950                | 0.0106 | 0.0049 |
| 316| 63.2821                | 0.0117 | 0.0016 |
| 317| 63.3413                | 0.0085 | 0.0007 |
| 318| 63.4045                | 0.0094 | 0.0014 |
| 322| 63.6525                | 0.0079 | 0.0004 |
| 323| 63.7118                | 0.0049 | 0.0011 |
| 324| 63.7777                | 0.0084 | 0.0004 |
| 325| 63.8424                | 0.0107 | 0.0003 |
| 326| 63.9041                | 0.0101 | 0.0003 |
| 332| 64.2746                | 0.0064 | 0.0009 |
| 333| 64.3369                | 0.0064 | 0.0008 |
| 334| 64.3981                | 0.0052 | 0.0029 |
| 335| 64.4622                | 0.0069 | 0.0009 |
| 336| 64.5293                | 0.0116 | 0.0020 |
| 337| 64.5895                | 0.0095 | 0.0015 |
| 338| 64.6516                | 0.0092 | 0.0023 |
| 339| 64.7115                | 0.0068 | 0.0025 |
| 347| 65.2125                | 0.0089 | 0.0020 |
| 348| 65.2719                | 0.0059 | 0.0012 |
| 349| 65.3340                | 0.0056 | 0.0015 |
| 364| 66.2550                | -0.0088| 0.0107 |
| 365| 66.3299                | 0.0038 | 0.0013 |
| 366| 66.3956                | 0.0071 | 0.0017 |
| 367| 66.4532                | 0.0023 | 0.0080 |
| 368| 66.5094                | -0.0039| 0.0051 |
| 369| 66.5773                | 0.0017 | 0.0025 |
| 370| 66.6383                | 0.0003 | 0.0021 |
| 371| 66.7073                | 0.0069 | 0.0002 |
| 372| 66.7645                | 0.0018 | 0.0003 |
| 373| 66.8297                | 0.0047 | 0.0011 |
| 380| 67.2594                | -0.0022| 0.0015 |
| 381| 67.3275                | 0.0036 | 0.0014 |
| 382| 67.3953                | 0.0090 | 0.0039 |
| 383| 67.4477                | -0.0010| 0.0017 |
| 384| 67.5073                | -0.0037| 0.0011 |
| 386| 67.6395                | 0.0038 | 0.0004 |
| 387| 67.7010                | 0.0029 | 0.0015 |
| 388| 67.7612                | 0.0007 | 0.0007 |
| 389| 67.8260                | 0.0032 | 0.0007 |
| 396| 68.2569                | -0.0025| 0.0006 |

*BJD − 2455900*
Table 9. (Continued.)

| E  | The timings of maximum* | $O - C$ | error |
|----|-------------------------|--------|-------|
| 397| 68.3225                 | 0.0008 | 0.0014|
| 398| 68.3934                 | 0.0094 | 0.0011|
| 399| 68.4489                 | 0.0024 | 0.0009|
| 400| 68.5112                 | 0.0024 | 0.0048|
| 401| 68.6375                 | 0.0040 | 0.0011|
| 402| 68.7648                 | 0.0065 | 0.0010|
| 404| 68.8215                 | 0.0009 | 0.0004|
| 405| 69.1997                 | 0.0049 | 0.0013|
| 411| 69.2693                 | 0.0121 | 0.0008|
| 413| 69.3251                 | 0.0056 | 0.0005|
| 428| 70.2563                 | 0.0014 | 0.0018|
| 429| 70.3202                 | 0.0029 | 0.0006|
| 430| 70.3757                 | -0.0039| 0.0010|
| 431| 70.4457                 | 0.0037 | 0.0008|
| 444| 71.2494                 | -0.0033| 0.0024|
| 445| 71.3122                 | -0.0029| 0.0010|
| 446| 71.3745                 | -0.0030| 0.0008|
| 450| 71.6260                 | -0.0009| 0.0006|
| 451| 71.6883                 | -0.0009| 0.0004|
| 453| 71.8107                 | -0.0033| 0.0003|
| 460| 72.2449                 | -0.0056| 0.0008|
| 483| 73.6721                 | -0.0127| 0.0005|
| 484| 73.7382                 | -0.0090| 0.0005|
| 485| 73.8001                 | -0.0095| 0.0006|
| 486| 73.8593                 | -0.0126| 0.0024|
| 487| 73.9334                 | -0.0009| 0.0029|
| 488| 73.9986                 | 0.0020 | 0.0011|
| 507| 75.1697                 | -0.0119| 0.0016|
| 508| 75.2275                 | -0.0164| 0.0008|
| 510| 75.3576                 | -0.0110| 0.0013|
| 524| 76.2239                 | -0.0177| 0.0009|
| 525| 76.2906                 | -0.0135| 0.0009|
| 526| 76.3473                 | -0.0191| 0.0015|
| 531| 76.6570                 | -0.0213| 0.0009|
| 535| 76.9046                 | -0.0231| 0.0028|
| 536| 76.9652                 | -0.0249| 0.0005|
| 540| 77.2188                 | -0.0207| 0.0007|
| 541| 77.2757                 | -0.0261| 0.0010|
| 542| 77.3456                 | -0.0186| 0.0014|
| 543| 77.3995                 | -0.0271| 0.0012|
| 544| 77.4730                 | -0.0159| 0.0026|
| 545| 77.5165                 | -0.0347| 0.0049|
| 546| 77.5930                 | -0.0207| 0.0013|
| 547| 77.6582                 | -0.0178| 0.0008|
| 556| 78.2144                 | -0.0229| 0.0012|
| 557| 78.2700                 | -0.0296| 0.0029|
| 558| 78.3321                 | -0.0299| 0.0023|
| 559| 78.4029                 | -0.0214| 0.0016|
| 560| 78.4656                 | -0.0211| 0.0006|
| 561| 78.5323                 | -0.0168| 0.0011|
| 562| 78.5949                 | -0.0165| 0.0013|
| 559| 78.4023                 | -0.0220| 0.0026|
| 564| 78.7156                 | -0.0205| 0.0006|
| 565| 78.7758                 | -0.0227| 0.0004|

*BJD−2455000
| E  | The timings of maximum\(^*\) | \(O - C\)  | error |
|----|-----------------------------|------------|-------|
| 566 | 78.8431                     | -0.0178    | 0.0011|
| 567 | 78.8988                     | -0.0245    | 0.0004|
| 568 | 78.9645                     | -0.0211    | 0.0004|
| 576 | 79.4610                     | -0.0235    | 0.0023|
| 580 | 79.7065                     | -0.0274    | 0.0006|
| 582 | 79.8861                     | 0.0350     | 0.0004|
| 583 | 79.9516                     | 0.0318     | 0.0005|
| 594 | 80.6291                     | 0.0404     | 0.0005|
| 598 | 80.8793                     | 0.0396     | 0.0006|
| 599 | 80.9474                     | 0.0338     | 0.0003|
| 604 | 81.2031                     | -0.0275    | 0.0010|
| 606 | 81.3254                     | -0.0300    | 0.0024|
| 615 | 81.9015                     | -0.0151    | 0.0005|

\(^*\)BJD−2455900.
### Table 10. Log of the maximum timings of negative superhumps during supercycle 2012 S3

| E   | The timings of maximum* | O − C  | error   |
|-----|-------------------------|--------|---------|
| 0   | 97.1285                 | 0.0055 | 0.0007  |
| 1   | 97.1998                 | 0.0144 | 0.0011  |
| 2   | 97.2467                 | −0.0010| 0.0010  |
| 3   | 97.3101                 | 0.0001 | 0.0005  |
| 10  | 97.7459                 | −0.0005| 0.0019  |
| 11  | 97.8009                 | −0.0078| 0.0006  |
| 12  | 97.8725                 | 0.0014 | 0.0007  |
| 13  | 97.9324                 | −0.0010| 0.0004  |
| 16  | 98.1268                 | 0.0064 | 0.0016  |
| 17  | 98.1821                 | −0.0007| 0.0004  |
| 18  | 98.2440                 | −0.0012| 0.0006  |
| 19  | 98.3111                 | 0.0036 | 0.0007  |
| 24  | 98.6186                 | −0.0006| 0.0020  |
| 25  | 98.6764                 | −0.0051| 0.0012  |
| 26  | 98.7449                 | 0.0010 | 0.0009  |
| 29  | 98.9216                 | −0.0093| 0.0006  |
| 32  | 99.1179                 | 0.0001 | 0.0019  |
| 33  | 99.1651                 | −0.0151| 0.0014  |
| 34  | 99.2442                 | 0.0016 | 0.0008  |
| 35  | 99.3059                 | 0.0010 | 0.0009  |
| 36  | 99.3706                 | 0.0034 | 0.0011  |
| 37  | 99.4256                 | −0.0040| 0.0046  |
| 38  | 99.4864                 | −0.0055| 0.0014  |
| 39  | 99.5562                 | 0.0020 | 0.0006  |
| 43  | 99.8123                 | 0.0087 | 0.0036  |
| 44  | 99.8596                 | −0.0064| 0.0019  |
| 45  | 99.9348                 | 0.0065 | 0.0016  |
| 46  | 99.9912                 | 0.0065 | 0.0007  |
| 47  | 100.0521                | −0.0009| 0.0003  |
| 48  | 100.1164                | 0.0011 | 0.0006  |
| 49  | 100.1772                | −0.0004| 0.0007  |
| 50  | 100.2437                | 0.0037 | 0.0010  |
| 51  | 100.3063                | 0.0040 | 0.0013  |
| 52  | 100.3700                | 0.0053 | 0.0007  |
| 53  | 100.4362                | 0.0092 | 0.0007  |
| 54  | 100.4960                | 0.0066 | 0.0006  |
| 55  | 100.5549                | 0.0032 | 0.0004  |
| 64  | 101.1046                | −0.0082| 0.0018  |
| 65  | 101.1817                | 0.0066 | 0.0004  |
| 66  | 101.2416                | 0.0042 | 0.0006  |
| 67  | 101.3031                | 0.0033 | 0.0007  |
| 68  | 101.3667                | 0.0046 | 0.0004  |
| 69  | 101.4326                | 0.0081 | 0.0003  |
| 70  | 101.4905                | 0.0037 | 0.0018  |
| 71  | 101.5597                | 0.0105 | 0.0009  |
| 72  | 101.6111                | −0.0004| 0.0015  |
| 73  | 101.6778                | 0.0040 | 0.0016  |
| 74  | 101.7428                | 0.0066 | 0.0003  |
| 75  | 101.7982                | −0.0003| 0.0004  |
| 76  | 101.8670                | 0.0061 | 0.0004  |
| 77  | 101.9293                | 0.0062 | 0.0004  |
| 82  | 102.2354                | 0.0005 | 0.0045  |
| 83  | 102.3024                | 0.0052 | 0.0014  |
| 84  | 102.3614                | 0.0018 | 0.0005  |
| 85  | 102.4294                | 0.0075 | 0.0012  |

*B JD − 2455000
Table 10. (Continued.)

| E    | The timings of maximum* | $O - C$ | error  |
|------|-------------------------|--------|--------|
| 89   | 102.6644                | -0.0069| 0.0017 |
| 99   | 103.3034                | 0.0087 | 0.0006 |
| 100  | 103.3635                | 0.0065 | 0.0004 |
| 101  | 103.4291                | 0.0098 | 0.0004 |
| 102  | 103.4956                | 0.0140 | 0.0012 |
| 103  | 103.5533                | 0.0093 | 0.0005 |
| 108  | 103.8699                | 0.0141 | 0.0015 |
| 114  | 104.2434                | 0.0137 | 0.0012 |
| 115  | 104.3011                | 0.0090 | 0.0005 |
| 116  | 104.3630                | 0.0085 | 0.0004 |
| 119  | 104.5510                | 0.0095 | 0.0007 |
| 120  | 104.6134                | 0.0096 | 0.0009 |
| 131  | 105.2997                | 0.0102 | 0.0008 |
| 132  | 105.3628                | 0.0109 | 0.0008 |
| 133  | 105.4323                | 0.0181 | 0.0006 |
| 134  | 105.4900                | 0.0135 | 0.0006 |
| 135  | 105.5506                | 0.0117 | 0.0008 |
| 136  | 105.6130                | 0.0118 | 0.0006 |
| 146  | 106.2346                | 0.0099 | 0.0025 |
| 147  | 106.3052                | 0.0182 | 0.0018 |
| 148  | 106.3596                | 0.0103 | 0.0007 |
| 149  | 106.4261                | 0.0145 | 0.0005 |
| 150  | 106.4897                | 0.0157 | 0.0011 |
| 151  | 106.5463                | 0.0100 | 0.0024 |
| 152  | 106.6084                | 0.0098 | 0.0024 |
| 153  | 106.6783                | 0.0173 | 0.0011 |
| 160  | 107.1090                | 0.0116 | 0.0009 |
| 161  | 107.1743                | 0.0146 | 0.0005 |
| 162  | 107.2327                | 0.0106 | 0.0015 |
| 163  | 107.3011                | 0.0167 | 0.0010 |
| 164  | 107.3592                | 0.0125 | 0.0003 |
| 165  | 107.4213                | 0.0122 | 0.0003 |
| 166  | 107.4855                | 0.0140 | 0.0010 |
| 167  | 107.5475                | 0.0137 | 0.0008 |
| 168  | 107.6096                | 0.0135 | 0.0015 |
| 177  | 108.1671                | 0.0099 | 0.0007 |
| 178  | 108.2313                | 0.0118 | 0.0005 |
| 179  | 108.2988                | 0.0169 | 0.0006 |
| 180  | 108.3652                | 0.0210 | 0.0008 |
| 181  | 108.4255                | 0.0189 | 0.0023 |
| 182  | 108.4826                | 0.0137 | 0.0012 |
| 183  | 108.5420                | 0.0108 | 0.0004 |
| 184  | 108.6097                | 0.0161 | 0.0022 |
| 186  | 108.7275                | 0.0092 | 0.0008 |
| 187  | 108.7995                | 0.0189 | 0.0010 |
| 188  | 108.8556                | 0.0127 | 0.0006 |
| 195  | 109.2988                | 0.0195 | 0.0004 |
| 196  | 109.3589                | 0.0172 | 0.0003 |
| 197  | 109.4181                | 0.0141 | 0.0003 |
| 198  | 109.4814                | 0.0151 | 0.0004 |
| 199  | 109.5440                | 0.0154 | 0.0005 |
| 200  | 109.6085                | 0.0175 | 0.0004 |
| 201  | 109.6689                | 0.0155 | 0.0004 |
| 202  | 109.7318                | 0.0161 | 0.0009 |
| 203  | 109.7930                | 0.0150 | 0.0004 |

* $BJD - 2455900$
| E  | The timings of maximum* | $O - C$  | error  |
|----|----------------------------|---------|--------|
| 204| 109.8587                  | 0.0183  | 0.0006 |
| 205| 109.9214                  | 0.0188  | 0.0003 |
| 211| 110.2958                  | 0.0191  | 0.0004 |
| 212| 110.3599                  | 0.0209  | 0.0006 |
| 213| 110.4176                  | 0.0162  | 0.0005 |
| 214| 110.4795                  | 0.0157  | 0.0004 |
| 215| 110.5428                  | 0.0167  | 0.0008 |
| 216| 110.6042                  | 0.0158  | 0.0005 |
| 218| 110.7313                  | 0.0182  | 0.0004 |
| 219| 110.7949                  | 0.0194  | 0.0004 |
| 220| 110.8566                  | 0.0188  | 0.0014 |
| 221| 110.9198                  | 0.0197  | 0.0006 |
| 227| 111.3036                  | 0.0294  | 0.0010 |
| 229| 111.4168                  | 0.0179  | 0.0006 |
| 230| 111.4847                  | 0.0234  | 0.0004 |
| 231| 111.5396                  | 0.0160  | 0.0005 |
| 232| 111.6095                  | 0.0236  | 0.0006 |
| 233| 111.6696                  | 0.0213  | 0.0011 |
| 234| 111.7295                  | 0.0189  | 0.0004 |
| 236| 111.8545                  | 0.0193  | 0.0003 |
| 241| 112.1665                  | 0.0196  | 0.0010 |
| 245| 112.3973                  | 0.0010  | 0.0010 |
| 246| 112.4567                  | −0.0019 | 0.0025 |
| 248| 112.6085                  | 0.0252  | 0.0011 |
| 260| 113.3509                  | 0.0195  | 0.0013 |
| 261| 113.4157                  | 0.0220  | 0.0009 |
| 262| 113.4774                  | 0.0214  | 0.0011 |
| 266| 113.7323                  | 0.0269  | 0.0004 |
| 268| 113.8440                  | 0.0139  | 0.0011 |
| 273| 114.1640                  | 0.0222  | 0.0013 |
| 271| 114.0452                  | 0.0281  | 0.0012 |
| 273| 114.1650                  | 0.0232  | 0.0009 |
| 274| 114.2261                  | 0.0219  | 0.0008 |
| 276| 114.3546                  | 0.0258  | 0.0006 |
| 277| 114.4196                  | 0.0284  | 0.0005 |
| 278| 114.4791                  | 0.0255  | 0.0007 |
| 279| 114.5433                  | 0.0274  | 0.0006 |
| 280| 114.6051                  | 0.0269  | 0.0008 |
| 281| 114.6646                  | 0.0240  | 0.0007 |
| 283| 114.7911                  | 0.0259  | 0.0006 |
| 284| 114.8540                  | 0.0264  | 0.0004 |
| 285| 114.9148                  | 0.0249  | 0.0007 |
| 288| 115.0969                  | 0.0200  | 0.0078 |
| 289| 115.1640                  | 0.0247  | 0.0006 |
| 290| 115.2175                  | 0.0159  | 0.0013 |
| 292| 115.3449                  | 0.0186  | 0.0007 |
| 293| 115.4055                  | 0.0168  | 0.0023 |
| 294| 115.4704                  | 0.0195  | 0.0006 |
| 295| 115.5328                  | 0.0195  | 0.0005 |
| 298| 115.7217                  | 0.0214  | 0.0012 |
| 299| 115.7842                  | 0.0215  | 0.0002 |
| 300| 115.8486                  | 0.0236  | 0.0007 |
| 301| 115.9119                  | 0.0245  | 0.0004 |
| 313| 116.6657                  | 0.0303  | 0.0033 |
| 315| 116.7813                  | 0.0212  | 0.0006 |

*BJD−2455000
Table 10. (Continued.)

| E   | The timings of maximum$^*$ | $O - C$    | error   |
|-----|---------------------------|-----------|---------|
| 316 | 116.8453                  | 0.0229    | 0.0005  |
| 317 | 116.9064                  | 0.0216    | 0.0003  |
| 347 | 118.7700                  | 0.0150    | 0.0004  |
| 348 | 118.8358                  | 0.0185    | 0.0008  |
| 349 | 118.8991                  | 0.0194    | 0.0003  |
| 351 | 119.0274                  | 0.0231    | 0.0008  |
| 352 | 119.0875                  | 0.0208    | 0.0004  |
| 353 | 119.1507                  | 0.0216    | 0.0006  |
| 354 | 119.2093                  | 0.0180    | 0.0016  |
| 355 | 119.2810                  | 0.0273    | 0.0006  |
| 356 | 119.3369                  | 0.0208    | 0.0005  |
| 357 | 119.4001                  | 0.0217    | 0.0006  |
| 358 | 119.4616                  | 0.0209    | 0.0005  |
| 359 | 119.5241                  | 0.0211    | 0.0007  |
| 361 | 119.6520                  | 0.0243    | 0.0018  |
| 362 | 119.7117                  | 0.0216    | 0.0006  |
| 363 | 119.7752                  | 0.0228    | 0.0024  |
| 367 | 120.0270                  | 0.0253    | 0.0007  |
| 368 | 120.0880                  | 0.0238    | 0.0006  |
| 372 | 120.3375                  | 0.0240    | 0.0008  |
| 375 | 120.4696                  | -0.0309   | 0.0006  |
| 383 | 121.0192                  | 0.0200    | 0.0023  |
| 384 | 121.0776                  | 0.0160    | 0.0018  |
| 385 | 121.1486                  | 0.0247    | 0.0012  |
| 387 | 121.2695                  | 0.0209    | 0.0010  |
| 389 | 121.3952                  | 0.0219    | 0.0007  |
| 394 | 121.7065                  | 0.0216    | 0.0005  |
| 396 | 121.8321                  | 0.0224    | 0.0005  |
| 397 | 121.9005                  | 0.0285    | 0.0010  |
| 398 | 121.9615                  | 0.0272    | 0.0008  |
| 399 | 122.0202                  | 0.0235    | 0.0016  |
| 405 | 122.3920                  | 0.0213    | 0.0014  |
| 407 | 122.5128                  | 0.0174    | 0.0011  |
| 410 | 122.7073                  | 0.0249    | 0.0010  |
| 411 | 122.7661                  | 0.0214    | 0.0006  |
| 412 | 122.8336                  | 0.0265    | 0.0007  |
| 416 | 123.0772                  | 0.0207    | 0.0009  |
| 417 | 123.1422                  | 0.0234    | 0.0013  |
| 419 | 123.2640                  | 0.0205    | 0.0036  |
| 421 | 123.3998                  | 0.0316    | 0.0019  |
| 436 | 124.3218                  | 0.0186    | 0.0004  |
| 437 | 124.3862                  | 0.0206    | 0.0010  |
| 448 | 125.0696                  | 0.0182    | 0.0006  |
| 449 | 125.1290                  | 0.0154    | 0.0006  |
| 450 | 125.1960                  | 0.0200    | 0.0005  |
| 453 | 125.3841                  | 0.0211    | 0.0005  |
| 454 | 125.4396                  | 0.0142    | 0.0005  |
| 455 | 125.5072                  | 0.0195    | 0.0007  |
| 456 | 125.5722                  | 0.0222    | 0.0007  |
| 459 | 125.7548                  | 0.0178    | 0.0018  |
| 460 | 125.8178                  | 0.0184    | 0.0012  |
| 461 | 125.8774                  | 0.0156    | 0.0004  |
| 462 | 125.9335                  | 0.0095    | 0.0008  |
| 465 | 126.1205                  | 0.0094    | 0.0025  |
| 466 | 126.1915                  | 0.0181    | 0.0014  |

$^*$BJD−2455900
Table 10. (Continued.)

| E  | The timings of maximum$^\star$ | $O - C$ | error  |
|----|-------------------------------|--------|--------|
| 469| 126.3737                      | 0.0132 | 0.0009 |
| 471| 126.4965                      | 0.0113 | 0.0007 |
| 484| 127.3128                      | 0.0172 | 0.0014 |
| 485| 127.3786                      | 0.0207 | 0.0016 |
| 486| 127.4282                      | 0.0079 | 0.0009 |
| 490| 127.6825                      | 0.0129 | 0.0004 |
| 491| 127.7365                      | 0.0046 | 0.0010 |
| 492| 127.8025                      | 0.0082 | 0.0017 |
| 493| 127.8728                      | 0.0162 | 0.0007 |
| 500| 128.3082                      | 0.0152 | 0.0008 |
| 501| 128.3750                      | 0.0197 | 0.0020 |
| 502| 128.4253                      | 0.0076 | 0.0009 |
| 503| 128.4947                      | 0.0147 | 0.0006 |
| 522| 129.6769                      | 0.0124 | 0.0022 |
| 523| 129.7289                      | 0.0021 | 0.0008 |
| 528| 130.0550                      | 0.0165 | 0.0012 |
| 533| 130.3596                      | 0.0094 | 0.0007 |
| 534| 130.4178                      | 0.0052 | 0.0008 |
| 535| 130.4837                      | 0.0088 | 0.0006 |
| 536| 130.5454                      | 0.0082 | 0.0012 |
| 555| 131.7311                      | 0.0094 | 0.0006 |
| 556| 131.7937                      | 0.0097 | 0.0005 |
| 557| 131.8586                      | 0.0122 | 0.0012 |

$^\star$BJD−2455900.