

A 68-day eclipse in the TESS aperture of TIC 431033666

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Tustin, California. Research note from the 0.80–0.90 degree ring around V345 Lac, 10 October 2026.

Abstract

TESS Quick-Look Pipeline photometry of TIC 431033666 shows three flat-bottomed eclipses, in sectors 16, 56 and 84. The center of the interval below 60 percent of normal light gives

$$\text{BJD}_{\text{TDB}} = 2458752.337 + 68.12269 E$$

where E is an integer cycle and the epoch is the sector 16 minimum. The residuals are -0.2 , $+0.5$ and -0.3 minutes. In the 200-second sectors the flux stays below 98 percent of normal for 10.4 hours and below 60 percent for about 3.8 hours. The minimum is 0.48 of the sector median. No second minimum is present at phase 0.5. The half-period and one-third-period epochs fall inside observed sectors, and those eclipses are absent.

The star is 6.0 arcsec from BD+53 2845 (TIC 431033672), which is 1.2 mag brighter in G . The same three times appear in that star’s QLP light curve at a depth of 19 percent. The centroid of TIC 431033666 shifts by less than 0.01 pixel. TESS pixels are 21 arcsec, so the photometry does not say which star is eclipsed. Neither star is in the AAVSO Variable Star Index or the General Catalogue of Variable Stars. Nothing in this note has been submitted to VSX.

1. Introduction

A cone of TESS QLP light curves around V345 Lac was searched for eclipses on stars brighter than $V = 12.5$. The ring from 0.80 to 0.90 degrees contains 173 such stars that had not been screened in the inner cones. One of them, 52 arcmin from V345 Lac, drops by half on a spacing of about 68 days. This note collects the catalog record and the TESS ephemeris.

The photometry is the public QLP product (Huang et al. 2020; Kunimoto et al. 2021). Catalog values are from the TESS Input Catalog (Stassun et al. 2019), Gaia DR3 (Gaia Collaboration 2023), 2MASS (Cutri et al. 2003), AllWISE (Cutri et al. 2013), SIMBAD and VizieR, queried on 9–10 October 2026. Cadences with a nonzero quality flag were removed, including the QLP poor-quality bit 2^{30} . Each sector was divided by its own median. No new observations were obtained.

2. The two stars

TIC 431033666 is Gaia DR3 2004767798943260288, at 22h 19m 04.511s, $+53^\circ 48' 36.71''$. Galactic longitude and latitude are $l = 101.547^\circ$ and $b = -2.613^\circ$. SIMBAD has no spectral type and no variable flag. Three bibliographic links are catalog papers (Huber et al. 2022; Kounkel and Covey 2019; Zari et al. 2018). There is no dedicated study of the star. It is not in Tycho-2 and not in Hipparcos.

Gaia DR3 measures a parallax of 2.082 ± 0.016 mas, an inverse-parallax distance of 480 pc. The renormalized unit-weight error is 0.874 and the non-single-star flag is 0. One radial velocity is published, -18.7 ± 3.3 km s $^{-1}$. Gaia GSP-Phot gives $T_{\text{eff}} = 8377$ K, $\log g = 4.21$, $[M/H] = -0.34$ and $A_G = 0.54$ mag. Those GSP-Phot numbers are copied as published and are not refit here. They describe a single late-A or early-F star. An eclipsing companion is not in that solution.

Six arcseconds to the south-southeast is BD+53 2845, TIC 431033672, TYC 3982-3094-1, Gaia DR3 2004767798946201600, at 22h 19m 04.76s, $+53^\circ 48' 31.1''$. The TIC copy of the Gaia identifier for this star is truncated and does not match DR3; the DR3 source above is the one at the BD star. SIMBAD types it B8 at quality flag D and gives $V = 9.84$ and $B = 10.02$. Its parallax is 2.038 ± 0.024 mas (491 pc) and its proper motion agrees with the fainter star at the level of 0.3 mas yr $^{-1}$. The two parallaxes differ by 0.044 mas, 1.5 times the combined uncertainty. A bound pair at about 2900 AU is allowed and not demonstrated. GSP-Phot gives $T_{\text{eff}} = 10177$ K and $\log g = 4.03$, in line with a mid-B dwarf, and a metallicity that is not used. RUWE is 0.833 and the non-single-star flag is 0. No Gaia radial velocity is published for the B8 star.

The 2MASS source 0.16 arcsec from TIC 431033666 has $J, H, K_s = 10.420, 10.317, 10.296$, quality AAA. The source 5.9 arcsec away, on BD+53 2845, has 9.513, 9.497, 9.443, also AAA. AllWISE at 0.24

arcsec has W1, W2, W3 = 10.255, 10.271, 10.268, quality AAA, variability flag nnnn, and a W4 value of quality U. The B8 star has W1, W2, W3 = 9.326, 9.348, 9.377, quality AAA, the same variability flag, and W4 of quality C. W1 – W2 is +0.02 mag for both. There is no large infrared excess in the bands with A quality.

Quantity	TIC 431033666	BD+53 2845
TIC / Tycho	431033666; not in Tycho	431033672; TYC 3982-3094-1
Gaia DR3	2004767798943260288	2004767798946201600
RA, Dec	22h 19m 04.511s, +53° 48' 36.71"	22h 19m 04.76s, +53° 48' 31.1"
Separation	52' from V345 Lac	6.0" from TIC 431033666
Parallax	2.082 ± 0.016 mas (480 pc)	2.038 ± 0.024 mas (491 pc)
Proper motion	+6.946, +1.578 mas yr ⁻¹	+6.630, +1.671 mas yr ⁻¹
RUWE / NSS	0.874 / 0	0.833 / 0
G, BP, RP	11.044, 11.201, 10.763	9.833, 9.904, 9.684
V, T	11.096, 10.820	9.837, 9.738
Spectral type	none in SIMBAD	B8 (SIMBAD, quality D)
GSP-Phot	8377 K, log g 4.21	10177 K, log g 4.03
Radial velocity	-18.7 ± 3.3 km s ⁻¹	none published
J, H, K _s	10.420, 10.317, 10.296	9.513, 9.497, 9.443
W1, W2, W3	10.255, 10.271, 10.268	9.326, 9.348, 9.377
TIC contamination	2.603	0.387

Table 1. Catalog properties. Distances are inverse parallaxes. Magnitudes are Gaia, TIC V and T, 2MASS and AllWISE. The TIC contamination ratio is the catalog aperture value, not a measured QLP dilution. GSP-Phot parameters assume a single star.

3. TESS photometry

QLP light curves exist for sectors 16, 17, 56, 57, 83 and 84. Sectors 16 and 17 are 30-minute cadence (KSPSAP_FLUX). The later sectors are 200-second cadence (DET_FLUX). Sectors 76 and 77 have no QLP v01 file for this TIC. The same six files exist for TIC 431033672.

A dip search at the 1.2 percent level flags the three deep events and also a shallow run in sector 57. The deep events are the subject of the ephemeris. The shallow run is described at the end of this section and is not used.

The mid-time adopted for each deep eclipse is the center of the interval in which the normalized flux stays below 0.60. That choice matches a flat bottom better than the single faintest cadence, which wanders along the bottom. Table 2 gives those times. A straight-line fit of mid-time against cycle number, with cycles 0, 16 and 27, is

$$T_0 = 1752.337 \text{ BTJD}, \quad P = 68.12269 \text{ d.}$$

BTJD is $\text{BJD}_{\text{TDB}} - 2457000$, and JD 2457000.0 is 2014 December 8 at 12:00 UT. The residuals of the three times are -0.2, +0.5 and -0.3 minutes. Sixteen and eleven are coprime, so a period that is an integer fraction of 68.12 days cannot pass through all three eclipses unless it also places extra eclipses in the sectors. The half-period epoch in sector 17, BTJD 1786.40, has minimum flux 0.997. Phase 0.5 in sector 57, BTJD 2876.36, has minimum flux 0.985. The one-third epoch in sector 17, BTJD 1775.04, has minimum flux 0.996. No other predicted primary of the 68.12-day ephemeris falls inside the six sectors. The three observed events are the whole set.

Sector	Mid-eclipse	UTC	Min. flux	Below 0.98	Below 0.60	Neighbor min.
16	1752.337	2019-09-25 20:05	0.489	10.0 h	3.5 h	0.810
56	2842.300	2022-09-19 19:12	0.482	10.4 h	3.8 h	0.810
84	3591.649	2024-10-08 03:35	0.489	10.4 h	3.8 h	0.811

Table 2. Eclipse times of TIC 431033666. The mid-time is the center of the run below flux 0.60. UTC uses JD 2457000.0 = 2014-12-08 12:00. The neighbor column is the minimum of TIC 431033672 inside ± 0.15 days of the same mid-time, on its own sector median.

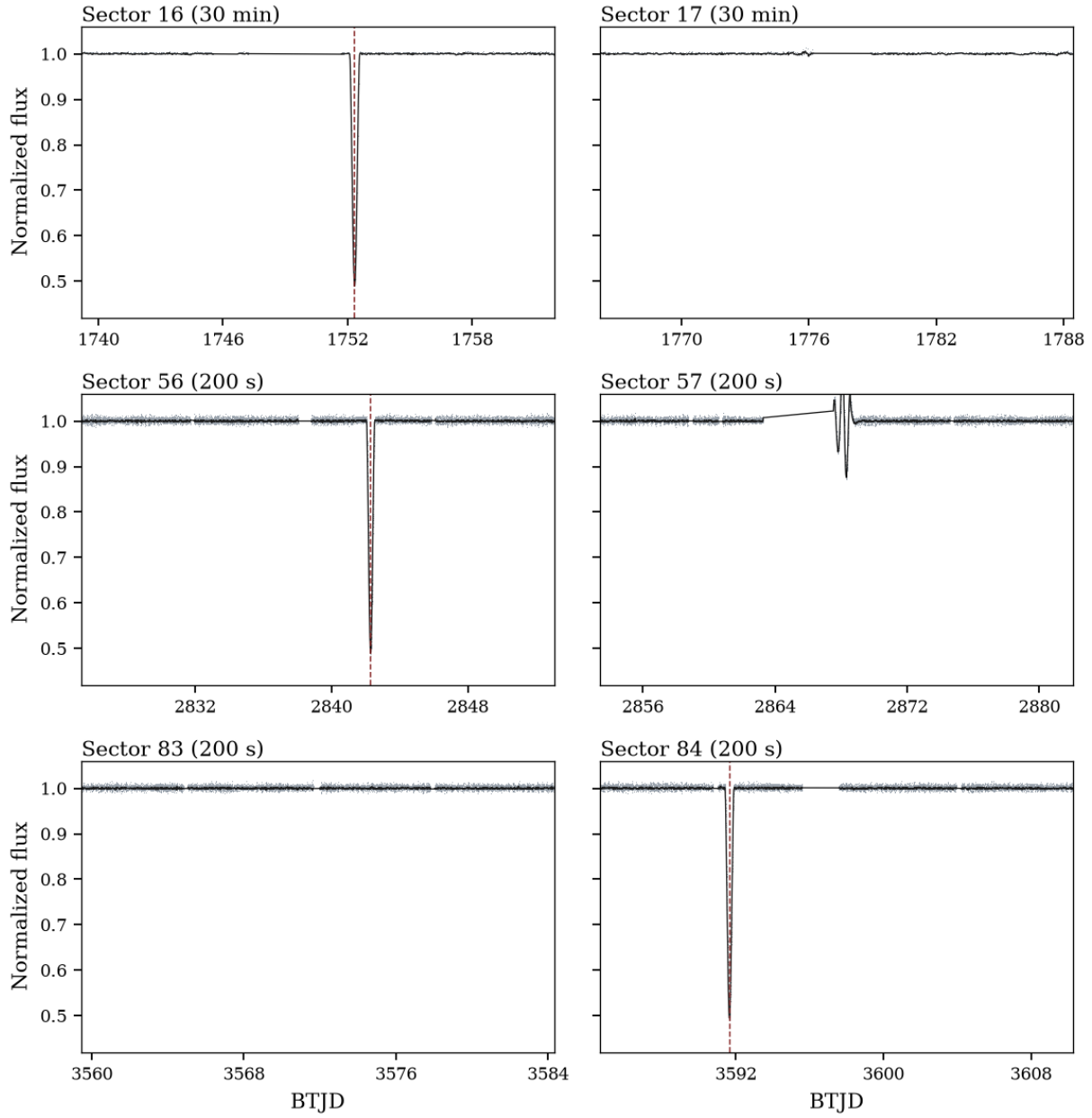


Figure 1. QLP light curves of TIC 431033666. Points are quality-zero cadences. The line is a 20-minute median. Dashed lines are the ephemeris of Table 2. Sector 17 contains the epoch required by a 34-day alias and does not eclipse.

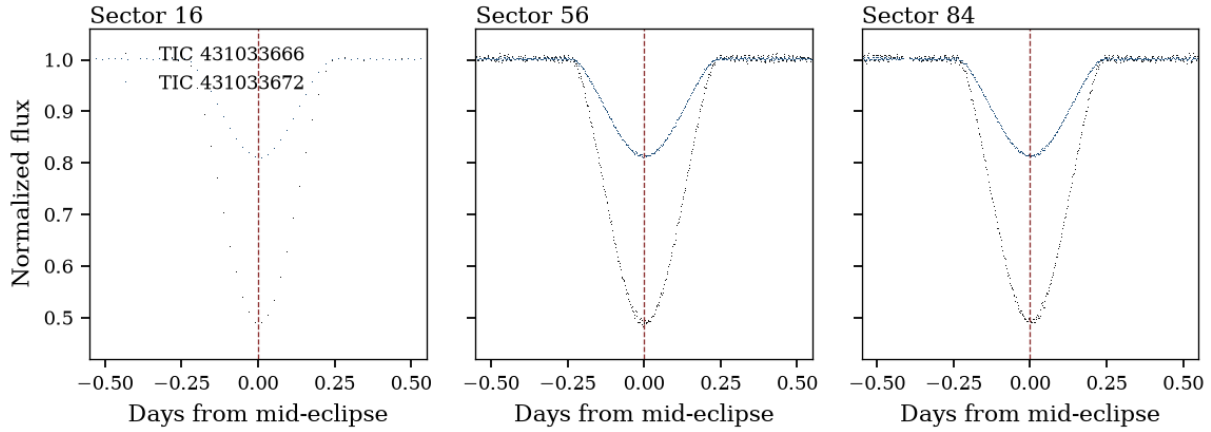


Figure 2. The three eclipses. Black is TIC 431033666. Blue is BD+53 2845 (TIC 431033672), normalized by its own sector median and plotted on the same time axis. Both extractions fade together. The fainter extraction reaches about half light. The brighter extraction reaches 0.81.

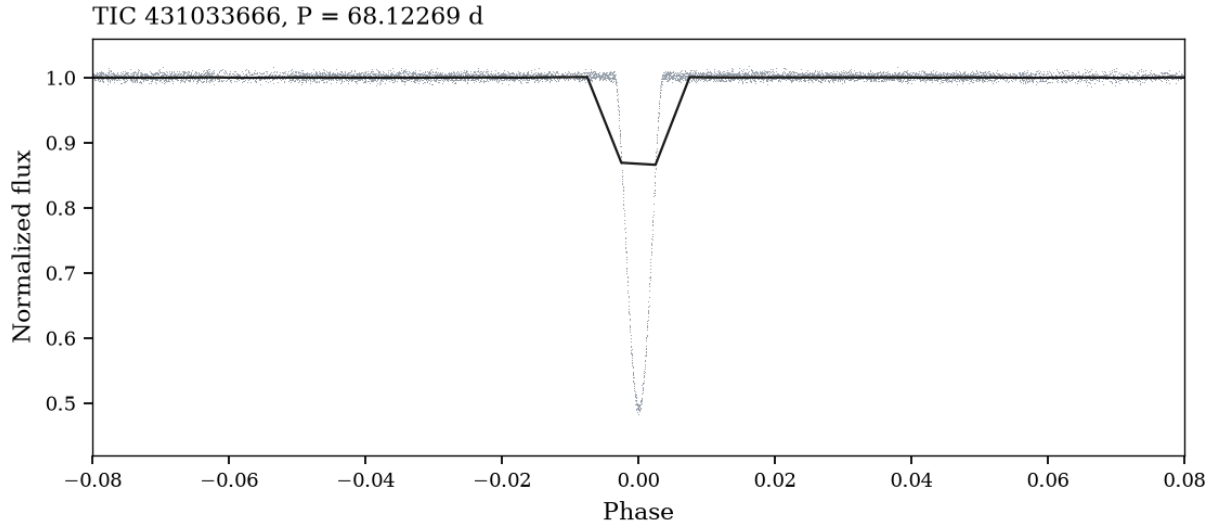


Figure 3. TIC 431033666 folded on $P = 68.12269$ d. The window is ± 0.08 in phase, about ± 5.5 days. The line is a median in phase. Phase 0.5 is outside this window and is flat in sector 57, as quoted above. The fold uses only the six QLP sectors.

4. Which star fades

The G magnitudes differ by 1.211. The fainter star is 25 percent of the summed light and the B8 star is 75 percent. A total eclipse of the whole fainter star would leave 75 percent of the sum, a drop of 0.31 mag. A total eclipse of one equal component of the fainter star, with the other component and the B8 star untouched, would leave 88 percent. The TIC contamination ratio of 2.60 says neighbors contribute 2.60 times the target, so the target is 28 percent of the catalog aperture. A total eclipse of that target would leave flux 0.72.

Neither QLP curve matches those numbers exactly. The extraction centered on TIC 431033666 falls to 0.48. The extraction centered on BD+53 2845 falls to 0.81, which is a 19 percent drop, between the two simple cases above. QLP is a different aperture from the TIC contamination ratio, and two stars 6 arcsec apart are not separated by a 21-arcsec pixel. During the sector 56 and 84 eclipses the SAP centroid of TIC 431033666 moves by 0.001 to 0.006 pixel, comparable to the out-of-eclipse scatter of 0.002 to 0.005 pixel. The data show one event in a shared aperture. They do not assign it to one star.

The flat bottom and the lack of a secondary at phase 0.5 fit an Algol-type eclipse, seen once per orbit in these sectors. The depth in a resolved aperture is not predicted here beyond the statement

that the eclipsing star, once separated, has to fade by more than the 19 percent seen on the bright extraction. A ground series that keeps the two stars in different apertures decides the question. At about 1 arcsec per pixel the pair is 6 pixels apart. In 2 to 3 arcsec seeing, a tight aperture on each star is the measurement. The comparison star should be a third star.

Sector 57 also contains a shallow dip from BTJD 2867.73 to 2868.43, minimum 0.869 on TIC 431033666 and 0.962 on TIC 431033672. It lasts about five hours. Its phase on the 68-day ephemeris is 0.38, not 0.0 or 0.5. It is not repeated in the other sectors and is not part of the fit.

5. Other surveys

No second time series was found that samples these eclipses. The checks were made on 10 October 2026 and only downloaded tables are counted.

ZTF DR23 has no object at either coordinate. The nearest cataloged source is 6.6 arcsec away, at reference magnitude 17.7, with one observation. Both stars are bright enough to saturate ZTF. The ASAS-SN variable-star catalog has no entry within 5 arcmin. The ASAS-SN photometry server did not accept a connection, so the all-sky light curves, if they exist, were not read. The public SuperWASP time-series table at the NASA Exoplanet Archive is empty for RA 334–338° and Dec +53 to +55°, while the surrounding tiles contain thousands of stars. Gaia did not release epoch photometry for either source. Pan-STARRS DR2 detections within an arcsecond of TIC 431033666 have PSF magnitudes near 26 and are saturation ghosts; none falls during an eclipse. ASAS-3 does not cover this declination. The Catalina photcat cone returned no object within 18 arcsec of either star. Hipparcos has neither star. Tycho-2 has only the mean magnitude of BD+53 2845.

The Northern Sky Variability Survey does list the blend. Two skydot entries lie on the B8 star, 4 to 5 arcsec from TIC 431033666: median unfiltered magnitude 10.071 with 102 good points, and 10.024 with 45 good points. The scatter about the median is 0.034 and 0.055 mag. VizieR carries those summary numbers and not the individual times. The SkyDOT server did not answer, so the 1999–2000 points were not phased.

6. The next eclipse

Cycle 38 falls at BTJD 4340.999, which is 2026-10-27 11:58 UTC. The following two are 2027-01-03 14:55 UTC and 2027-03-12 17:52 UTC. The residual of the fit is under 10 minutes, and the sector 16 mid-time comes from 30-minute cadences. Measuring the center at flux 0.55, 0.60 or 0.80 moves the predicted clock time by about 10 minutes. Cycle 38 should be treated as uncertain by about 20 minutes. Times below are quoted to the minute and should be read with that uncertainty.

Using the 200-second eclipses, the flux is 2 percent below normal for 10.4 hours and below 60 percent of normal for 3.8 hours. Around the predicted mid-time that is 2026-10-27 06:46 UTC to 2026-10-27 17:11 UTC for the whole fade, and 10:04 to 13:53 UTC on the flat bottom.

On 27 October 2026 the clocks in the United States are still on daylight time. Mid-eclipse is 04:58 PDT and 06:58 CDT. The fade starts at 23:46 PDT on 26 October and at 01:46 CDT on 27 October. At the start, the star is about 53° up from Tustin and about 43° up from Fort Davis, Texas. At mid-eclipse it is about 10° up from Tustin and about 2° up from Fort Davis. A telescope in Texas can record the ingress. The flat bottom is at a few degrees altitude and in morning twilight. The recovery is after the star has set. From Britain and central Europe the star is up and the Sun is up.

The useful observation is a resolved time series of both stars through the ingress, continued as long as the field is high enough. One star fading, and the other holding, identifies the eclipsing star. A blended aperture will show a shallow dip and will not answer that question. No equipment was used for this note, and the star has not been submitted to VSX.

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