

Twelve-day eclipses of TIC 330247030

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Abstract

TESS Quick-Look Pipeline photometry at TYC 3986-528-1 (TIC 330247030) shows eclipses at both conjunctions. Eleven primary minima, in sectors 16, 17, 56, 57, 83 and 84, give

$$\text{BJD}_{\text{TDB}} = 2458758.683 + 12.47873 E,$$

where E is an integer cycle counted from the sector 16 primary and the epoch is BJD_{TDB} , equal to $\text{BJD}_{\text{TDB}} 1758.683$. The primary is 10.8 to 11.4 percent deep. The secondary, at phase 0.501, is 7.2 to 7.6 percent deep. Residuals of the primary times are 8 minutes rms and 19 minutes at worst. The minima are V-shaped, about 0.40 days from continuum to continuum.

The star is already in the AAVSO Variable Star Index as a Gaia variable of unspecified type, period 0.0246243 days (35.46 minutes), range 11.22 to 11.36 in G . Gaia DR3 puts the source in the short-timescale table and not in the eclipsing-binary table. The same fifty Gaia G transits have a standard deviation of only 0.022 mag; the 0.14 mag range is a few faint points. TESS 200-second photometry outside eclipse is flat at the 0.2 percent level and has no coherent signal at the Gaia period. The 12.5-day eclipses are the new result.

The TIC contamination ratio is 0.31. No centroid test was done. The eclipses are in the QLP light curve of this TIC. They are not yet shown to belong to this star rather than to a neighbor inside the aperture. The star is absent from the General Catalogue of Variable Stars and from the TESS short-cadence eclipsing-binary catalog of Prša et al. (2022).

1. Introduction

A cone of TESS QLP light curves around V345 Lac was searched for eclipses on stars brighter than $V = 12.5$. Inside 0.60 degrees that search produced two eclipsing signals that are written up separately. The ring from 0.60 to 0.71 degrees contains 144 such stars. One of them, 39.2 arcmin from V345 Lac, drops by about 11 percent on a 12.48-day spacing, with a second eclipse halfway between. This note collects the catalog record of that star 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), SIMBAD and VizieR, queried on 9 October 2026. No new observations were obtained, and nothing in this note has been submitted to VSX.

2. The star

TIC 330247030 is TYC 3986-528-1, GSC 03986-00528, Gaia DR3 2005420908854866432 and 2MASS J22142388+5429261, at 22h 14m 23.881s, $+54^\circ 29' 26.10''$. Galactic longitude and latitude are $l = 101.356^\circ$ and $b = -1.666^\circ$. SIMBAD also carries the luminous-star identification LF 4 +54 220, from McCuskey (1955), and [BBB73] 200, from Barbier et al. (1973). SIMBAD lists five bibliographic links. All of them are catalog papers. There is no dedicated study of the star.

SIMBAD lists the spectral type A0 at its lowest quality flag and attaches no reference to the type. VSX lists spectral type A. The TIC effective temperature is 8257 K, with $\log g = 3.59$, a radius of 3.77 solar radii and a mass of 2.03 solar masses. Those TIC values assume a single star. They describe an evolved early-A star, not a dwarf, even though the TIC luminosity-class flag says DWARF. Gaia GSP-Phot did not publish a temperature for this source. An A0 dwarf is

hotter than 8257 K; the type and the TIC temperature are left as separate catalog facts.

The Gaia DR3 parallax is 0.777 ± 0.016 mas, an inverse-parallax distance of 1287 pc. The TIC distance, 1259 ± 50 pc, is the Bailer-Jones (2018) Gaia DR2 value and is not used below. The renormalized unit-weight error is 0.837 and the non-single-star flag is 0. There is no Gaia spectroscopic orbit. The single Gaia radial velocity is -3.2 ± 9.2 km s⁻¹. Proper motion is $+2.452 \pm 0.017$, -2.326 ± 0.015 mas yr⁻¹.

The JMMC stellar-diameter catalog (Bourges et al. 2014) lists a limb-darkened diameter of 0.0263 ± 0.0008 mas. That diameter is a surface-brightness estimate from the broadband photometry, not an interferometric measurement. At the Gaia parallax it is 3.6 solar radii, in line with the TIC radius, as expected if both numbers come from the same fluxes.

AllWISE W1, W2 and W3 are 10.448, 10.471 and 10.487, all photometric quality A. W1 minus W2 is -0.02 mag. W4 is an upper limit (quality U). The AllWISE variability flag is n. There is no large infrared excess.

Quantity	Value	Source
Identifiers	TIC 330247030; TYC 3986-528-1; Gaia DR3 2005420908854866432	TIC, Gaia
Other names	2MASS J22142388+5429261; GSC 03986-00528; LF 4 +54 220	2MASS, GSC, SIMBAD
RA, Dec (ICRS)	22h 14m 23.881s, +54° 29' 26.10"	Gaia DR3
Galactic l, b	101.356°, -1.666°	Gaia DR3
Separation	39.2 arcmin from V345 Lac	this note
Parallax	0.777 ± 0.016 mas (1287 pc, inverse)	Gaia DR3
Proper motion	$+2.452 \pm 0.017$, -2.326 ± 0.015 mas yr ⁻¹	Gaia DR3
RUWE / NSS	0.837 / 0	Gaia DR3
G, BP, RP	11.231, 11.368, 10.980; BP - RP = 0.388	Gaia DR3
V, B, T	11.488 ± 0.018 , 11.459 ± 0.17 , 11.049	Tycho-2, TIC
J, H, K	10.656, 10.633, 10.542 (AAA)	2MASS
W1, W2, W3	10.448, 10.471, 10.487; W4 an upper limit	AllWISE
Spectral type	A0 (SIMBAD, quality D); A (VSX)	SIMBAD, VSX
Teff, log g	8257^{+188}_{-135} K, 3.59	TIC
Radius, mass	$3.77 +0.14/-0.24$ solar radii; $2.03 +0.40/-0.23$ solar masses	TIC, single-star
Angular diameter	0.0263 ± 0.0008 mas, photometric	JSDC v2
Radial velocity	-3.2 ± 9.2 km s ⁻¹	Gaia DR3
E(B - V)	0.155	TIC, Pan-STARRS
Contamination	0.312	TIC

Table 1. Catalog properties. Magnitudes are Vega for Tycho, 2MASS and WISE. The TIC radius, mass and temperature assume a single star. The Tycho B uncertainty is 0.17 mag, so B - V is not a useful color; BP - RP is.

3. The published 35-minute variation

Gaia marks the source VARIABLE. It is in gaiadr3.vari_short_timescale and not in gaiadr3.vari_eclipsing_binary. The classifier result table has no row. The short-timescale table gives a frequency of 40.61035 d⁻¹, which is a period of 0.0246243 days, 35.46 minutes, and an amplitude estimate of 0.100 mag. VSX copies that solution: name Gaia DR3 2005420908854866432, OID 8084646, type VAR, period 0.0246243 days, maximum 11.22 G, minimum 11.36 G, discoverer the Gaia collaboration (Watson, Henden and Price 2006).

The Gaia G time series behind that range is 50 field-of-view transits spread over 998 days. The faintest is G = 11.356 and the brightest is G = 11.216, a full range of 0.140 mag. The standard deviation is 0.022 mag, the trimmed range is 0.025 mag, and the median absolute deviation is 0.0035 mag. The skewness is 4.5 and the kurtosis is 22. The 0.14 mag range is a tail

of a few faint measurements, not a 0.14 mag oscillation sampled throughout its cycle. A variogram in the same table has a single timescale, 0.32 days, which is not 35 minutes.

TESS does not show the 35-minute signal. In sectors 56, 57, 83 and 84 the 200-second QLP flux, with both eclipses cut out, has a standard deviation of 0.23 percent. A sine fit at the Gaia frequency returns an amplitude of 0.02 mmag. A 0.10 mag signal would have survived the QLP detrending. Sectors 16 and 17 are 30-minute cadence and cannot test a 35-minute period. The out-of-eclipse light in the later sectors is constant at the level of this note.

A 12.5-day eclipse whose duty cycle is a few percent will fall in about two of fifty random Gaia samples and will produce a faint tail of exactly this kind. That reading explains the Gaia range, the skewness and the failure of the eclipsing-binary classifier, which did not have enough eclipses to classify. It is an interpretation of the published summary statistics, not a re-reduction of the Gaia time series. The 35-minute period is reported because VSX and Gaia publish it. It is not confirmed, and it is not the period of the eclipses.

4. TESS photometry

QLP light curves were retrieved for every sector in which a v01 light curve exists: 16 and 17 at 30-minute cadence (KSPSAP_FLUX) and 56, 57, 83 and 84 at 200-second cadence (DET_FLUX). Sectors 76 and 77 return HTTP 404 from the QLP archive for this TIC. Cadences with a nonzero quality flag were removed. Each sector was divided by its own median.

A dip is a run in which a 30-minute median stays at least 3 percent below the sector median, longer than 0.06 days and shorter than 1.5 days, allowing gaps under 0.03 days. The mid-time is the minimum of that median. The depth is one minus the minimum. The width in the tables is the time spent below 3 percent, not a contact-to-contact duration.

Twenty such dips are present. Eleven are 10.8 to 11.4 percent deep and are the primaries in Table 2. Nine are 7.2 to 7.6 percent deep and fall at phase 0.500 to 0.502; they are the secondaries in Table 3. One further dip, in sector 56 at BTJD 2831.95, is the cycle-86 primary with its bottom removed. The predicted time, BTJD 2831.854, sits in a gap. Unflagged samples on the egress reach 7.3 percent below the median. One quality-flagged sample reaches about 10 percent. That event is not in the fit.

Sector 17 contains two primaries. The secondary that should fall near BTJD 1777.40 is inside a data gap that runs from about 1776.9 to 1777.9. The following secondary falls after the end of the sector.

Sector	Mid-time (BTJD)	Cycle	O–C (min)	Depth (%)	Width (d)
16	1758.681	0	-2.9	11.15	0.271
17	1771.160	1	-2.5	10.94	0.271
17	1783.639	2	-2.1	10.97	0.271
56	2844.330	87	-3.6	11.39	0.292
57	2856.821	88	+14.1	11.01	0.287
57	2869.303	89	+18.8	11.13	0.282
57	2881.763	90	-8.2	10.83	0.280
83	3568.097	145	-2.7	11.30	0.287
83	3580.576	146	-2.3	11.23	0.292
84	3593.049	147	-10.5	11.18	0.285
84	3605.535	148	-0.1	11.30	0.292

Table 2. Primary minima used in the ephemeris. The width is the time the 30-minute median stays more than 3 percent below the sector median. O–C is against T0 = 1758.683 BTJD and P = 12.47873 d.

Sector	Mid-time (BTJD)	Phase	Depth (%)	Width (d)
16	1739.972	0.5006	7.32	0.229
16	1752.451	0.5006	7.24	0.229
56	2850.590	0.5015	7.35	0.252
57	2863.057	0.5005	7.45	0.245
57	2875.550	0.5017	7.30	0.245
83	3561.856	0.4997	7.26	0.245
83	3574.347	0.5007	7.55	0.248
84	3586.829	0.5010	7.28	0.243
84	3599.306	0.5008	7.40	0.248

Table 3. Secondary minima. Phase is computed from the primary ephemeris. The mean phase is 0.5008.

5. Ephemeris and eclipse shape

A linear least squares fit of the eleven primary times, with integer cycles counted from the first, gives

$$T_0 = 1758.683 \text{ BTJD}, \quad P = 12.47873 \text{ d.}$$

$\text{BTJD} = \text{BJD}_{\text{TDB}} - 2457000$, so the same epoch is $\text{BJD}_{\text{TDB}} 2458758.683$. The cycles are 0, 1, 2, then 87 through 90, then 145 through 148: three TESS visits separated by about a year, 148 cycles in all. Against the times in Table 2 the rms residual is 8.4 minutes and the largest residual is 19 minutes. A formal least-squares uncertainty is smaller than that scatter. The period is quoted to 0.00001 days and should not be read as better than about 0.0001 days. Two sector 57 primaries are 14 and 19 minutes late, and the third is 8 minutes early. The other eight are within 11 minutes.

The secondary sits at phase 0.5008, fourteen minutes after phase 0.5, inside the timing scatter of the primaries. The orbit is close to circular. No eccentricity is fitted.

The eclipses are partial. In the sector 56 primary at BTJD 2844.330 the 200-second flux is on the continuum 0.20 days before and after mid-eclipse, so the full width is about 0.40 days, and the time below 1 percent is 0.345 days. The bottom is rounded. There is no flat floor. The secondary is the same shape at two-thirds the depth. Figure 1 shows the six sectors. Figure 2 is the phase fold.

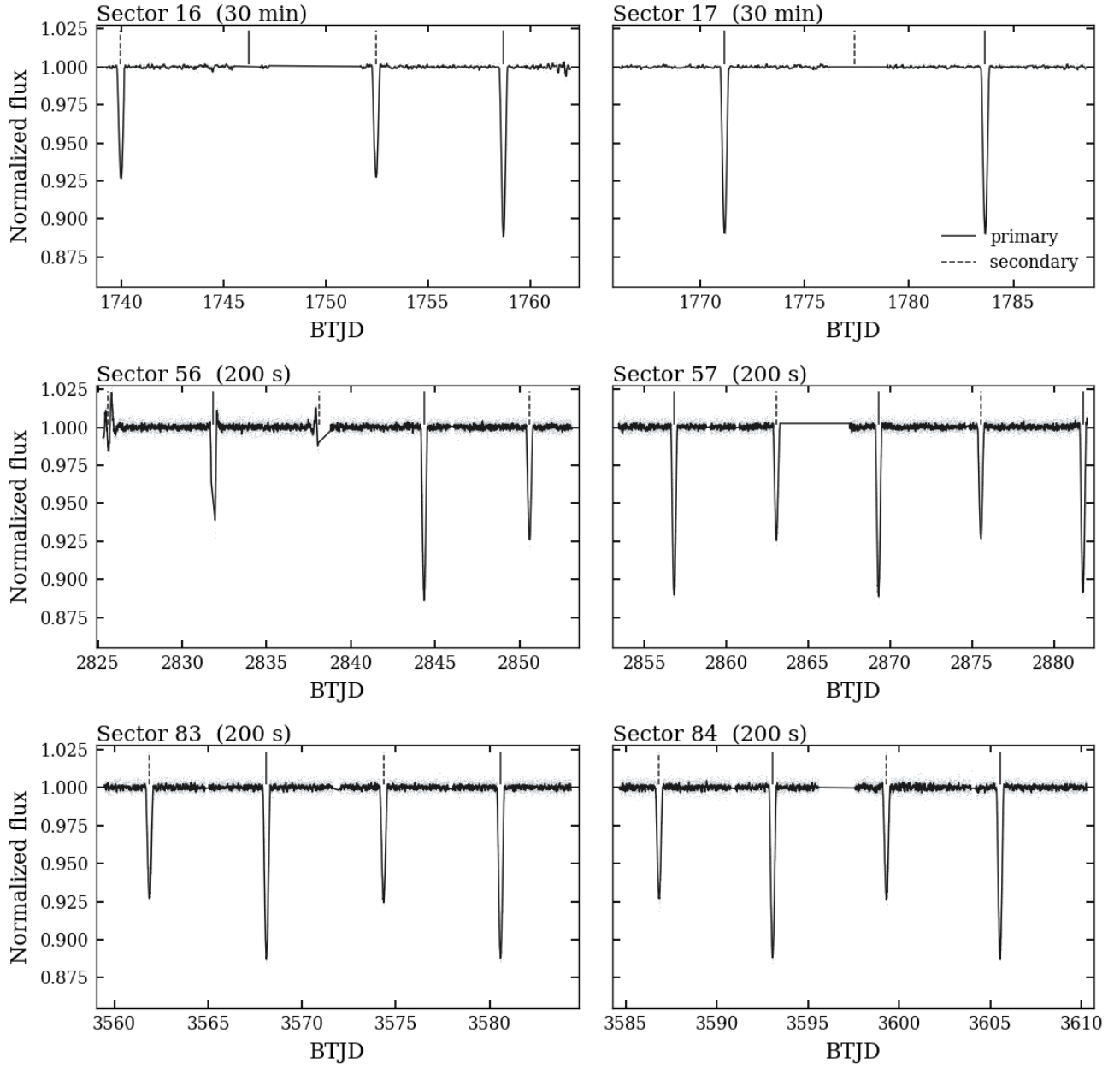


Figure 1. QLP light curves with quality-flagged cadences removed, each divided by its sector median. The black line is a 30-minute median. Marks at the top of each panel are the ephemeris of Section 5: solid for a primary conjunction, dashed for phase 0.5. The sector 17 secondary and the bottom of the cycle-86 primary fall in gaps.

TIC 330247030 phased on the eclipse ephemeris

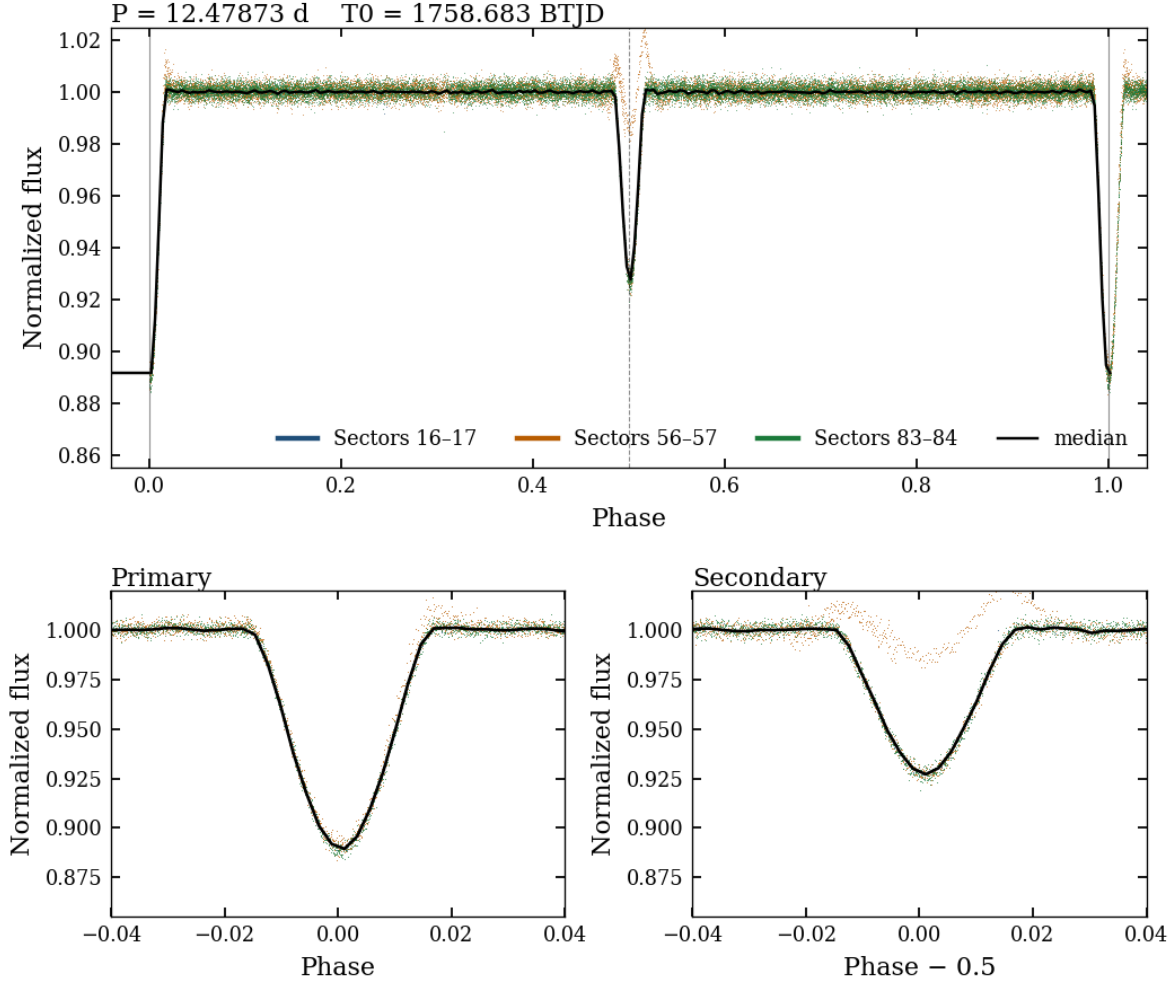


Figure 2. The same photometry phased on $P = 12.47873$ d with phase zero at BTJD 1758.683. The line is a median. The lower panels expand the two eclipses. Flux outside eclipse is constant. Both eclipses are V-shaped.

6. Dilution, and what this does not show

The TIC contamination ratio is 0.312, so neighboring flux in the TESS aperture is 31 percent of the target flux. If the eclipses belong to TIC 330247030, the undiluted depths are about 14.8 and 9.7 percent. If instead the whole signal belongs to some other star that supplies that 31 percent, that star has to drop by about 48 percent at the primary. Either reading is an eclipsing binary. Neither is selected by the light curve alone.

Inside one arcminute the only neighbor bright enough to produce an 11 percent aperture dip is Gaia DR3 2005420840135397504, 46.9 arcsec from the target, $G = 12.84$. Its G flux is 23 percent of the target, and its parallax is 0.312 mas, so it is a different star at a different distance. A total eclipse of that neighbor, seen together with the target, is deep enough to look like the observed dip. Stars within 45 arcsec are all fainter than $G = 14.6$. The nearest, at 6.5 arcsec, is $G = 15.93$ and can contribute at most about 1 percent if it vanishes. No difference-image centroid was measured. A ground observation that resolves the 47-arcsec pair would decide which star fades.

The TIC radius is not turned into a companion radius here. Both eclipses are deep, so both stars are luminous if the signal is on the target, and the single-star TIC parameters are then the wrong description of either component. A central eclipse of a 3.8-solar-radius star in a 12.48-day orbit at 2 solar masses would last about half a day even for a small companion. The observed full width, about 0.40 days, is shorter. A partial eclipse does that. A smaller star in the aperture does it too. The durations are measured, not modelled.

The next primary minimum on this ephemeris is BTJD 4329.301, 2026 October 15, 19:13 UTC. The uncertainty to carry is the timing residual, about 20 minutes, not the formal error of the fit. Later primaries follow every 12.47873 days.

7. Conclusions

TIC 330247030, a $V = 11.49$ star 39 arcmin from V345 Lac, has eclipses in its TESS QLP light curve at both conjunctions. The ephemeris is $T_0 = 1758.683$ BTJD and $P = 12.47873$ days. The primary depth is 11 percent and the secondary, at phase 0.50, is 7 percent. Eleven primaries over 148 cycles leave an O–C scatter of 8 minutes.

VSX already lists the star, under its Gaia DR3 name, as a 35-minute variable with a G range of 0.14 mag. That range is the extreme of fifty Gaia samples whose typical scatter is 0.02 mag, and the 35-minute period is absent from the TESS 200-second light curve. Gaia did not classify the source as an eclipsing binary. The 12.5-day eclipses are not that published signal.

The result is an ephemeris and a cross-match. The contamination ratio is 0.31, a star of $G = 12.84$ lies 47 arcsec away, and no centroid test has been done. The system should not be cited as a confirmed eclipse of TIC 330247030 until the dip is shown to be on that star.

References

- Barbier, M., Bernard, A., Bigay, J. H., and Garnier, R. 1973, *A&A*, 27, 421.
- Bourges, L., Lafrasse, S., Mella, G., et al. 2014, *ASP Conf. Ser.*, 485, 223, the JMMC stellar diameter catalog.
- Cutri, R. M., Wright, E. L., Conrow, T., et al. 2013, *AllWISE*, yCat II/328.
- Gaia Collaboration. 2023, *A&A*, 674, A1, Gaia DR3, including the variability tables.
- Huang, C. X., Vanderburg, A., Pál, A., et al. 2020, *RNAAS*, 4, 204, the TESS QLP.
- Kunimoto, M., Huang, C. X., Tey, E., et al. 2021, *RNAAS*, 5, 234.
- McCuskey, S. W. 1955, *ApJS*, 2, 75.
- Prša, A., Kochoska, A., Conroy, K. E., et al. 2022, *ApJS*, 258, 16.
- Ricker, G. R., Winn, J. N., Vanderspek, R., et al. 2015, *JATIS*, 1, 014003.
- Samus, N. N., Kazarovets, E. V., Durlevich, O. V., Kireeva, N. N., and Pastukhova, E. N. 2017, *Astron. Rep.*, 61, 80, the GCVS.
- Skrutskie, M. F., Cutri, R. M., Stiening, R., et al. 2006, *AJ*, 131, 1163, 2MASS.
- Stassun, K. G., Oelkers, R. J., Paegert, M., et al. 2019, *AJ*, 158, 138, the TIC.
- Watson, C. L., Henden, A. A., and Price, A. 2006, *Society for Astronomical Sciences Annual Symposium*, 25, 47, VSX.
- Data. QLP light curves from archive.stsci.edu, TIC 330247030, sectors 16, 17, 56, 57, 83 and 84. Sectors 76 and 77 are not in the QLP v01 archive for this TIC (HTTP 404 on 9 October 2026). Gaia values are from gaiadr3.gaia_source, vari_summary, vari_short_timescale and astrophysical_parameters for source 2005420908854866432. The tables nss_two_body_orbit and vari_classifier_result returned no row, and the GSP-Phot temperatures are null. VSX is from a 0.75-degree cone at V345 Lac on the same date; the match is 0.01 arcsec. The GCVS has no row within 1 arcmin. The Prša et al. (2022) catalog has no row within 2 arcmin. AllWISE, 2MASS and the JSDC are from VizieR. SIMBAD was queried the same day.