

TESS Transit Times from 2026 Do Not Confirm the Reported Orbital Decay of WASP-22 b

STEFANO IVAN STINGA ¹

¹*Independent researcher*

ABSTRACT

W. Wang et al. (2024) reported that the orbital period of the hot Jupiter WASP-22 b is shrinking by 71.8 ± 17.1 ms yr^{−1}. At that rate, 2026 transits would arrive 8.8 minutes earlier than a constant-period ephemeris fitted to the refereed 2006–2018 times predicts. I measured 14 transit times from TESS Sectors 105–107 and re-measured 5 from Sector 4 (2018). The 2026 transits arrive 1.3 ± 1.2 minutes early, consistent with a constant period. A quadratic ephemeris fitted to all 28 times gives $dP/dt = -18 \pm 7$ ms yr^{−1}, or -6 ± 8 ms yr^{−1} without two season-averaged times from 2006–2007. The reported rate is excluded at 7.3σ , or 2.6 – 2.9σ allowing for its published uncertainty. A constant acceleration at the rate seen in 2008–2009 radial velocities is excluded at 5σ or more. The remaining curvature is consistent with, but does not establish, the light-travel effect of the companion’s curving radial-velocity trend.

Keywords: Hot Jupiters (753) — Transit timing variation method (1710) — Exoplanet tides (497) — Exoplanet dynamics (490)

1. INTRODUCTION

WASP-22 b is a hot Jupiter on a 3.53-day orbit (P. F. L. Maxted et al. 2010). The radial velocities (RVs) of its host show a trend from a third body: $+37.8 \pm 2.2$ m s^{−1} yr^{−1} in 2008–2009 (D. R. Anderson et al. 2011), but $+21.3^{+2.8}_{-2.7}$ m s^{−1} yr^{−1} over 2008–2013 (H. A. Knutson et al. 2014). W. Wang et al. (2024) fitted 16 transit times from 2006–2018 and reported $dP/dt = -71.76 \pm 17.12$ ms yr^{−1}, a possible sign of tidal orbital decay.

A line-of-sight acceleration a also changes the observed period, by $dP/dt = Pa/c$ (e.g., L. G. Bouma et al. 2020), and J. N. Winn & G. Stefánsson (2025) attributed the apparent decay of WASP-4 b to this effect. For WASP-22 b, 1 m s^{−1} yr^{−1} gives 1.02 ms yr^{−1}. The RV trend therefore predicts a period change of the opposite sign. TESS (G. R. Ricker et al. 2015) re-observed WASP-22 in 2026, eight years after its first visit, when the two hypotheses predict transit times 13.6 minutes apart.

2. DATA AND METHOD

I used the SPOC 2-minute PDCSAP light curves (J. M. Jenkins et al. 2016) of TIC 257567854 from Sector 4 (2018 October–November) and Sectors 105–107 (2026 June–September), keeping cadences with QUALITY = 0.

I modelled the transits with quadratic limb darkening, integrated over each exposure. I fitted the shape jointly to all complete transits ($R_p/R_\star = 0.0990$, $a/R_\star = 8.68$, $b = 0.06$), then each transit’s mid-time with the shape fixed and a linear baseline. Uncertainties come from the χ^2 curvature, inflated by $\sqrt{\chi^2_\nu}$ when above 1 and by the red-noise factor β (J. N. Winn et al. 2008; maximum over 10–40-minute bins). Simulations with correlated noise show these uncertainties are good to 6%. Requiring each transit to be complete (no gap over 30 minutes) and at least 80% of its baseline to be covered left 5 transits from 2018 and 14 from 2026 (median uncertainty 59 s).

My Sector 4 times agree with those of E. S. Ivshina & J. N. Winn (2022) to 6 s rms. A second, separately written analysis of the same light curves, using batman and emcee, agrees to 5 s rms on the 14 common 2026 transits and, on the same 28 times, in dP/dt to 0.3 ms yr^{−1}.

For earlier epochs I used the nine refereed ground-based times compiled by J. Southworth et al. (2016), two of them season averages of 2006 and 2007 WASP-South photometry.

3. RESULTS

A linear ephemeris fitted to the 14 refereed 2006–2018 times (these nine and the five Sector 4 times of [E. S. Ivshina & J. N. Winn 2022](#)) has $\chi^2 = 29.4$ for 12 degrees of freedom, so I scaled its uncertainties by 1.57. A quadratic fit to the same times gives $dP/dt = -73 \pm 22 \text{ ms yr}^{-1}$ (uncertainties scaled by 1.16), reproducing [W. Wang et al. \(2024\)](#).

The 2026 transits (Figure 1) arrive 1.28 ± 0.27 minutes earlier than the linear ephemeris predicts (± 1.19 minutes including its extrapolation). The reported rate predicted 8.8 minutes early (6.3σ away), and a constant acceleration of $+37.8 \text{ m s}^{-1} \text{ yr}^{-1}$ predicted 4.7 minutes late (5.0σ). A constant period is 1.1σ away. Including the uncertainty of the quadratic fit itself, the pre-2026 times predicted the 2026 transits 9.0 ± 2.9 minutes early, 2.7σ from what was observed.

A quadratic ephemeris fitted to all 28 times gives $dP/dt = -18 \pm 7 \text{ ms yr}^{-1}$ (uncertainties scaled by 1.18), favoured over a linear ephemeris by $\Delta\text{BIC} = 4.9$. Fixing dP/dt at $-71.76 \text{ ms yr}^{-1}$ raises χ^2 by 74 (54 with scaled uncertainties), an exclusion at 7.3σ ; allowing for the published $\pm 17.12 \text{ ms yr}^{-1}$, the difference is 2.9σ (2.6σ counting the shared pre-2026 times). The curvature depends on the 2006–2007 season averages: without them, $dP/dt = -6 \pm 8 \text{ ms yr}^{-1}$, and with the ground-based uncertainties scaled instead, about -11 ms yr^{-1} ; either way the linear ephemeris is preferred ($\Delta\text{BIC} = 1.4\text{--}2.5$). In all variants, including the Sector 4 times of [E. S. Ivshina & J. N. Winn \(2022\)](#) or three unreferenced 2025 times from the Exoplanet Transit Database ([S. Poddaný et al. 2010](#)), the reported rate is excluded at $7.2\text{--}7.9\sigma$.

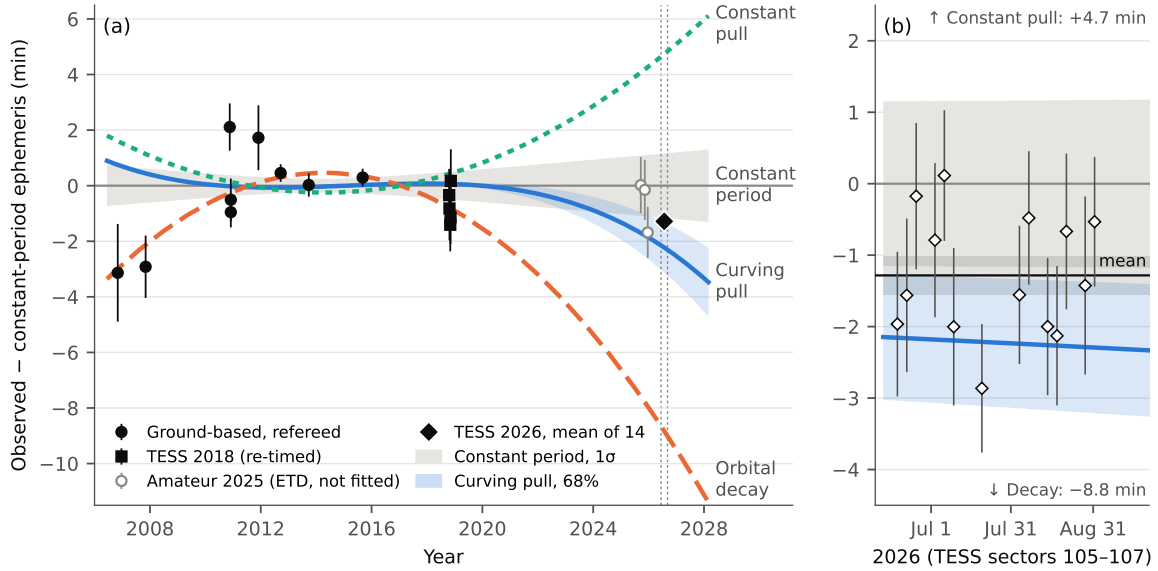


Figure 1. (a) Transit times minus the constant-period ephemeris of the 14 refereed 2006–2018 times; grey band: its 1σ extrapolation. Circles: ground-based times; squares: TESS 2018, re-timed here; diamond: mean of the 14 TESS 2026 transits; open circles: unreferenced 2025 times from the Exoplanet Transit Database (ETD), not fitted. Curves: decay at $-71.76 \text{ ms yr}^{-1}$ (dashed), constant $+37.8 \text{ m s}^{-1} \text{ yr}^{-1}$ acceleration (“constant pull”, dotted), and the curving RV trend (“curving pull”, solid; 68% band from the RV fit, extrapolated after 2013). (b) The 2026 window (vertical dotted lines in a): single transits, their mean ($\pm 1\sigma$) and off-scale predictions.

4. DISCUSSION

A constant acceleration of $+37.8 \text{ m s}^{-1} \text{ yr}^{-1}$ ($dP/dt = +38.5 \text{ ms yr}^{-1}$) is excluded at $5.4\text{--}7.9\sigma$ across the variants, and the $+21.3 \text{ m s}^{-1} \text{ yr}^{-1}$ of [H. A. Knutson et al. \(2014\)](#) at $3.4\text{--}5.5\sigma$. Unless the orbit also decays, the acceleration has changed; the RVs show this directly.

My fit to the 71 published out-of-transit RVs ([P. F. L. Maxted et al. 2010](#); [D. R. Anderson et al. 2011](#); [H. A. Knutson et al. 2014](#)) gives $d^2v/dt^2 = -6.3 \pm 1.1 \text{ m s}^{-1} \text{ yr}^{-2}$ ($\Delta\text{BIC} = 16.7$ over a linear trend). In this model, and for companion periods above about 25 years, the acceleration crossed zero around 2015 and may now point toward us; shorter periods fit nearly as well and predict otherwise. All such predictions extrapolate 13 years beyond the last RV (2013 December). Through the light-travel delay, the quadratic RV trend would make a quadratic fit to the 28 times

return $dP/dt = -15$ (-23 to -6) ms yr^{-1} , and circular orbits with 15–50-year periods -18 to -10 ms yr^{-1} , close to the measured value. The timing cannot yet separate this delay from a constant period: scaled freely, its amplitude is 0.32 ± 0.47 times the RV prediction.

A new RV epoch would decide: once instrument offsets are calibrated, the systemic velocity should now differ from its late-2009 value by -340 to $+90$ m s^{-1} , depending on the companion’s period, against $+640$ m s^{-1} for a constant acceleration.

ACKNOWLEDGMENTS

This paper includes data collected by the TESS mission, obtained from MAST at the Space Telescope Science Institute (Sectors 4 and 105–107; [doi:10.17909/t9-nmc8-f686](https://doi.org/10.17909/t9-nmc8-f686)). Funding for the TESS mission is provided by NASA’s Science Mission Directorate. I thank Y. Jongen for timings shared through the Exoplanet Transit Database. I used Claude (Anthropic, claude-opus-5-5) to write both analyses’ code, run them and draft this note. I checked the results, and I take responsibility for the content. Data and code: [doi:10.5281/zenodo.23395079](https://doi.org/10.5281/zenodo.23395079).

Facilities: TESS

Software: astropy (Astropy Collaboration 2022), batman, emcee, matplotlib, numpy, scipy

REFERENCES

- Anderson, D. R., Collier Cameron, A., Gillon, M., et al. 2011, *A&A*, 534, A16, doi: [10.1051/0004-6361/201117597](https://doi.org/10.1051/0004-6361/201117597)
- Astropy Collaboration, Price-Whelan, A. M., Lim, P. L., et al. 2022, *ApJ*, 935, 167, doi: [10.3847/1538-4357/ac7c74](https://doi.org/10.3847/1538-4357/ac7c74)
- Bouma, L. G., Winn, J. N., Howard, A. W., et al. 2020, *ApJL*, 893, L29, doi: [10.3847/2041-8213/ab8563](https://doi.org/10.3847/2041-8213/ab8563)
- Ivshina, E. S., & Winn, J. N. 2022, *ApJS*, 259, 62, doi: [10.3847/1538-4365/ac545b](https://doi.org/10.3847/1538-4365/ac545b)
- Jenkins, J. M., Twicken, J. D., McCauliff, S., et al. 2016, in *Proc. SPIE*, Vol. 9913, Software and Cyberinfrastructure for Astronomy IV, 99133E, doi: [10.1117/12.2233418](https://doi.org/10.1117/12.2233418)
- Knutson, H. A., Fulton, B. J., Montet, B. T., et al. 2014, *ApJ*, 785, 126, doi: [10.1088/0004-637X/785/2/126](https://doi.org/10.1088/0004-637X/785/2/126)
- Maxted, P. F. L., Anderson, D. R., Gillon, M., et al. 2010, *AJ*, 140, 2007, doi: [10.1088/0004-6256/140/6/2007](https://doi.org/10.1088/0004-6256/140/6/2007)
- Poddaný, S., Brát, L., & Pejcha, O. 2010, *NewA*, 15, 297, doi: [10.1016/j.newast.2009.09.001](https://doi.org/10.1016/j.newast.2009.09.001)
- Ricker, G. R., Winn, J. N., Vanderspek, R., et al. 2015, *Journal of Astronomical Telescopes, Instruments, and Systems*, 1, 014003, doi: [10.1117/1.JATIS.1.1.014003](https://doi.org/10.1117/1.JATIS.1.1.014003)
- Southworth, J., Tregloan-Reed, J., Andersen, M. I., et al. 2016, *MNRAS*, 457, 4205, doi: [10.1093/mnras/stw279](https://doi.org/10.1093/mnras/stw279)
- Wang, W., Zhang, Z., Chen, Z., et al. 2024, *ApJS*, 270, 14, doi: [10.3847/1538-4365/ad0847](https://doi.org/10.3847/1538-4365/ad0847)
- Winn, J. N., Holman, M. J., Torres, G., et al. 2008, *ApJ*, 683, 1076, doi: [10.1086/589737](https://doi.org/10.1086/589737)
- Winn, J. N., & Stefánsson, G. 2025, *PSJ*, 6, 300, doi: [10.3847/PSJ/ae21db](https://doi.org/10.3847/PSJ/ae21db)