EXPLORE Targets

Updated 2026 January 30

Target selection

The targets in this section considered suitable for observation by amateur astronomers;

- ExoClock database entries identified as having TTVs
- entries in the NASA Exoplanet Archive whose 'Data show Transit Timing Variations' which also appear on the ExoClock database but not listed as exhibiting TTVs
- searches of the NASA Exoplanet Archive require a space after the planet number e.g. WASP-148 b whereas the ExoClock database does not e.g. WASP-148b.
- those listed in the paper 'Exoplanet Ephemerides Change Observations (ExoEcho). I. Transit Timing Analysis of 37 Exoplanets Using HST/WFC3 Data'
- additional targets e.g. Warm Jupiters, Neptunes, Super Earths for which Radial Velocity and TTV data can be combined
- targets suitable for amateur astronomers would typically be in the range V mag 10-13 with a minimum transit depth of 10 mmag

Contiguous observations

There are some exoplanets which exhibit very large TTVs and thus their transits are difficult to predict. Observing such transits could involve amateur astronomers from e.g.; Europe, the Americas and Japan to give coverage over a wide range of time zones. Negative observations would be useful as they would constrain the parameters of the subject exoplanet system and observers should not feel that they have wasted their time in such instances.

AAVSO and BAA members will be notified by email should such opportunities occur.

Data input

Observations of non-ExoClock targets can only be input to the AAVSO database as per the guide on the EXPLORE 2000 web page.

Scheduling

Two facilities are useful for determining the TTV targets that are observable at a given location for a given night or series of nights: the Swarthm3.65ore Transit Finder and the ExoWorlds Spies Transit Scheduler.

Use the Swarthmore Transit finder for non-ExoClock targets and input as follows;

- Target list; Select ‘Single object with given ephemeris’ and enter data in resulting table

For the non-ExoClock targets enter the ‘BJD of mid-transit’ and Transit duration as below.

Target	BJD of mid-transit	Transit duration (hrs)
TOI-1305.01 (TIC 232679662)	2459909.736326	6.699
TOI-3686.01 (TIC 13533330)	2459899.580713	3.614
TOI-3850.01 (TIC 143008050)	2460352.826100	4.696
TOI-4007.01 (TIC 389910188)	2499905.980067	3.609

- Observatory; Select ‘Enter specific latitude/longitude/timezone’ and enter required data
- Complete other entries as required

Plots

The screen shots are taken from Exoplanetpie and LcTools and produced by Roger Dymock and Siegfried Vanaverbeke.

Planet	ExoClock status	RA Dec	V mag	Depth (mmag)	Period (days)	Minimum telescope aperture required (inches)
HAT-P-7b (HAT-P-7 Ab TOI-1265.01 TIC 424865156 Kep ID 10666592 KOI Name K00002.01 Kepler-2b)	TTVs	19:28:59.35 +47:58:10.2	10.48	7.41	2.2047	5.00
HAT-P-13b (TOI-5374.01 TIC 20096620)	Low	08:39:31.81 +47:21:07.3	10.42	8.25	2.9162	5.73

HAT-P-18b (TOI-2127.01 TIC 21744120)	Low	17:05:23.15 +33:00:44.9	12.76	24.28	5.5080	6.95
K2-19b (TOI-5145.01 TIC 281885301 EPIC 201505350)	TTVs	11:39:50.48 +00:36:12.9	13.00	7.63	7.9210	12.53
Qatar-1b (TOI-1465.01 TIC 236887394)	Low	20:13:31.62 +65:09:43.5	12.84	25.4	1.4200	7.02
TOI-216.01 (TIC 55652896)	TTVs	05:49:36.41 -54:54:38.6	9.72	20.94	34.5073	5.55
TOI-1130c (TOI-1130.01 (TIC 254113311)	Alert	19:05:30.22 -41:26:15.1	11.59	16.44	8.3498	5.00
TOI-1305.01 (TIC 232679662)	Not an ExoClock target	18:49:53.89 +55:15:59	9.92	21.57	7.8514	~5.50
TOI-3686.01 (TIC 13533330)	Not an EXoClock target	02:27:36.14 +59:57:09.8	12.00	14.47	5.0778	~5.00
TOI-3850.01 (TIC 143008050)	Not an ExoClock target	12:10:50.27 +66 57 07.8	12.96	10.87	14.4833	8.40
TOI-4007.01 (TIC 389910188)	Not an ExoClock target	23:29:20.27 62:19:31.9	13.14	11.91	4.5432	8.20
TrES-3b (TOI-2126.01 TIC 116264089)	Low	17:52:07.02 +37:32:46.2	12.40	28.34	1.3061	5.82
WASP-4b (TOI-232.01 TIC 402026209)	Low	23:34:15.09 -42:03:41.0	12.48	31.37	1.3382	5.54
WASP-12b (TOI-1725.01 TIC 86396382)	TTVs	06:30:32.80 +29:40:20.3	11.57	17.81	1.0914	5.00
WASP-19b (TOI-655.01 TIC 35516889)	TTVs	09:53:40.08 -45:39:33.1	12.31	22.96	0.7888	5.92

WASP-43b (TOI-656.01 TIC 36734222)	Low	10:19:38.01 -09:48:22.6	12.4	29.73	0.8135	5.85
WASP-148b (TOI-2064.01 TIC 115524421)	TTVs	16:56:31.34 +44:18:09.5	12.04	8.79	8.8038	7.95

Alternative names are shown in brackets;

- TOI; TESS Object of Interest
- TIC; TESS Input Catalogue ID

Searches of the NASA Exoplanet Archive require a space after the planet number e.g. WASP-148 b whereas the ExoClock database does not e.g. WASP-148b.

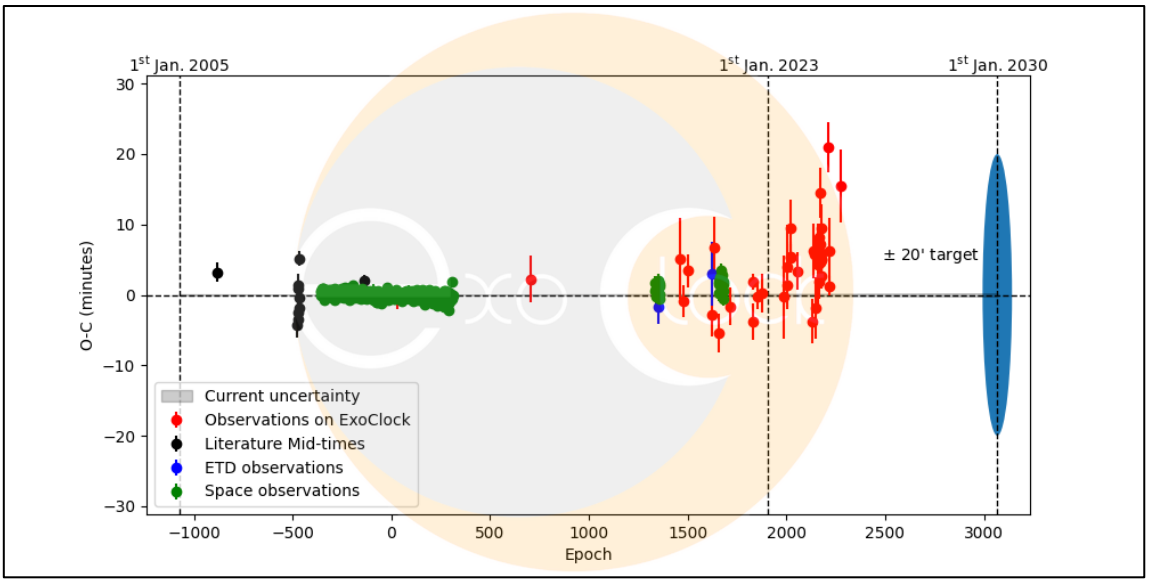
Transit predictions for an observer's location can be obtained from;

The ExoWorlds Spies Transit Scheduler

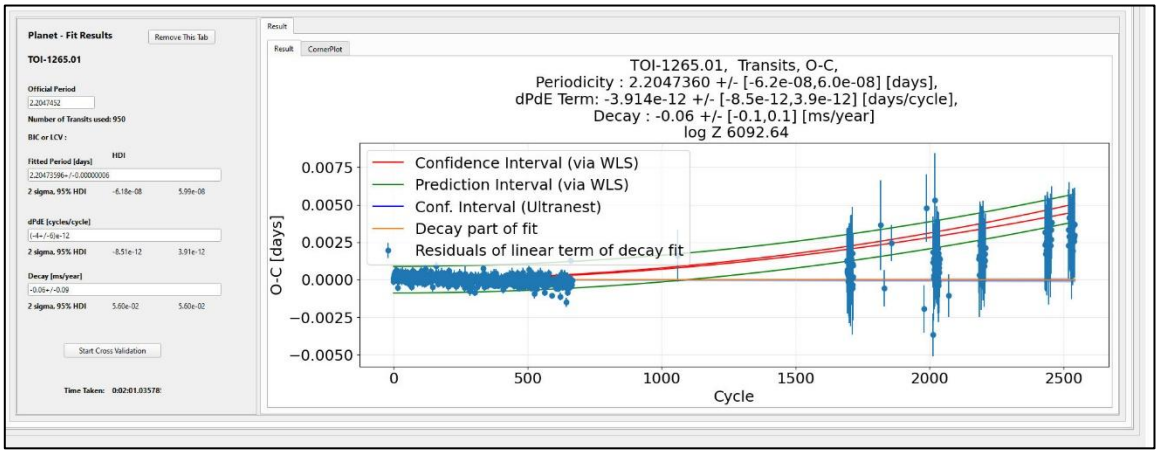
or

Find Exoplanet Transits

HAT-P-7b



ExoClock database

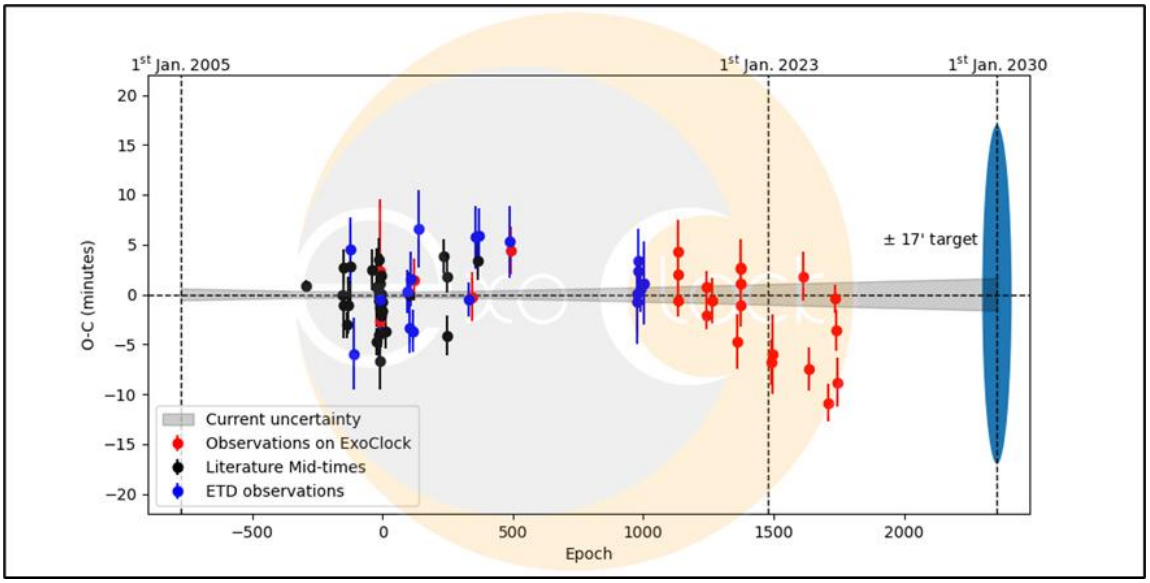


Exoplanetpie

Exoplanetpie analysis indicates an increasing orbital period or an evolving eccentric orbit. The latter is explored in a paper which describes the influence of a third star in the system.

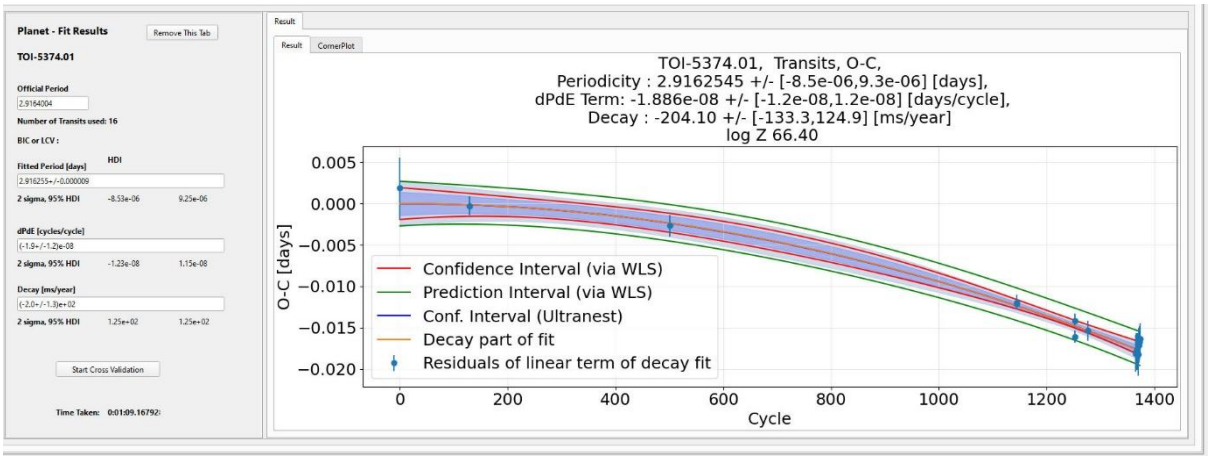
HAT-P-13b

HAT-P-13c is a massive outer planet on a highly eccentric orbit, period 428.5 +/-3 days. Orbital period of HAT-P-13b is 2.916 days. The high mass and eccentricity of the outer planet should induce TTVs of the inner planet - paper [HAT-P-13b,c: A TRANSITING HOT JUPITER WITH A MASSIVE OUTER COMPANION ON AN ECCENTRIC ORBIT*]



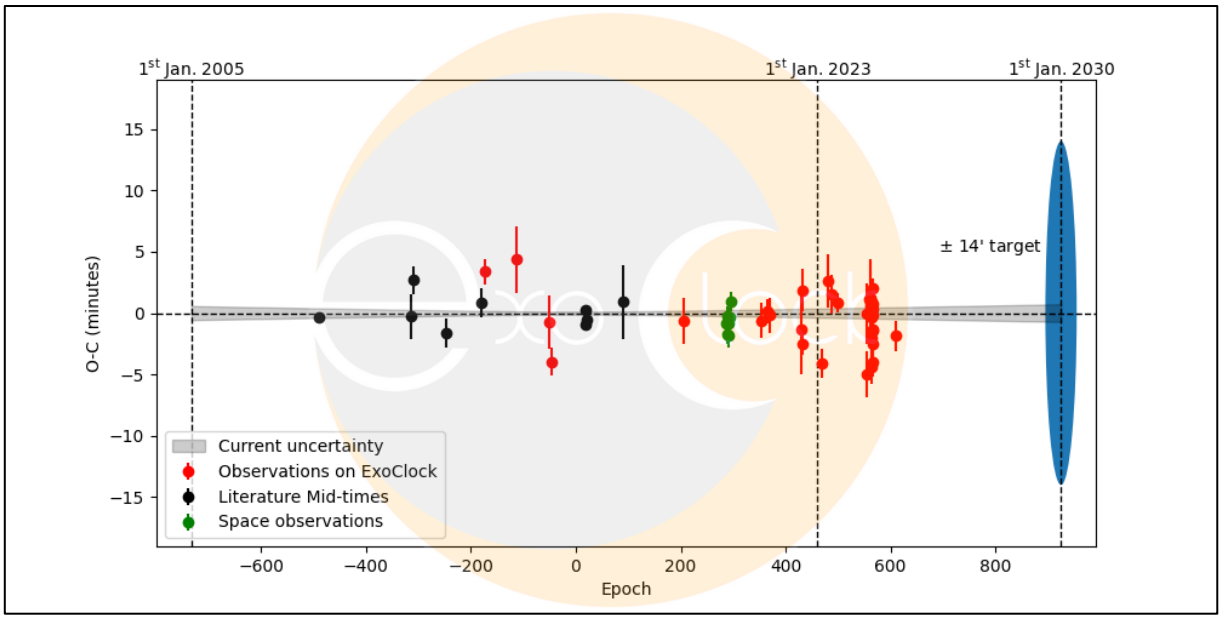
ExoClock database

Observations suggest an increasing and then decreasing orbital period. Possibly due to the presence of an additional exoplanet or a precessing eccentric orbit.

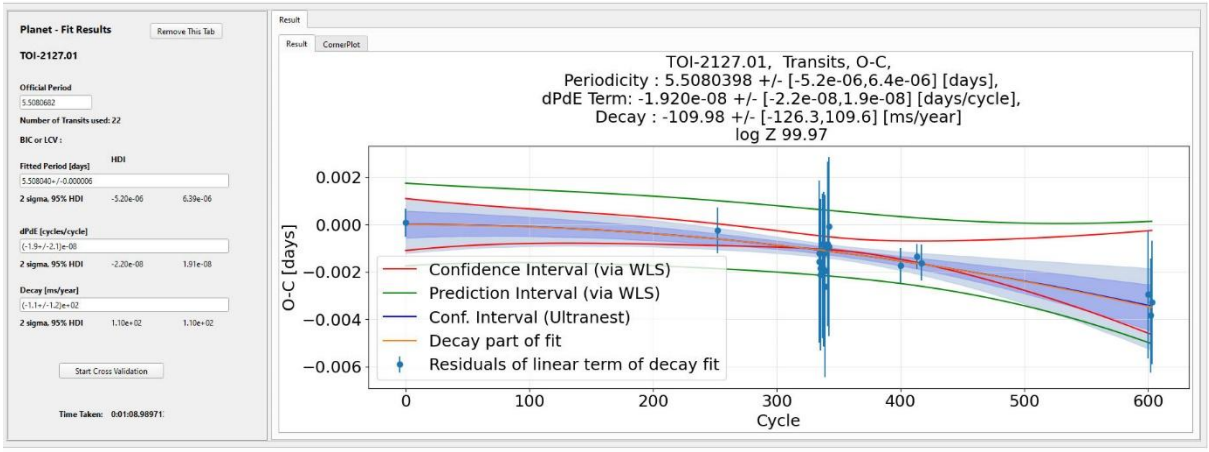


Exoplanetpie analysis indicates a decaying orbit.

HAT-P-18b

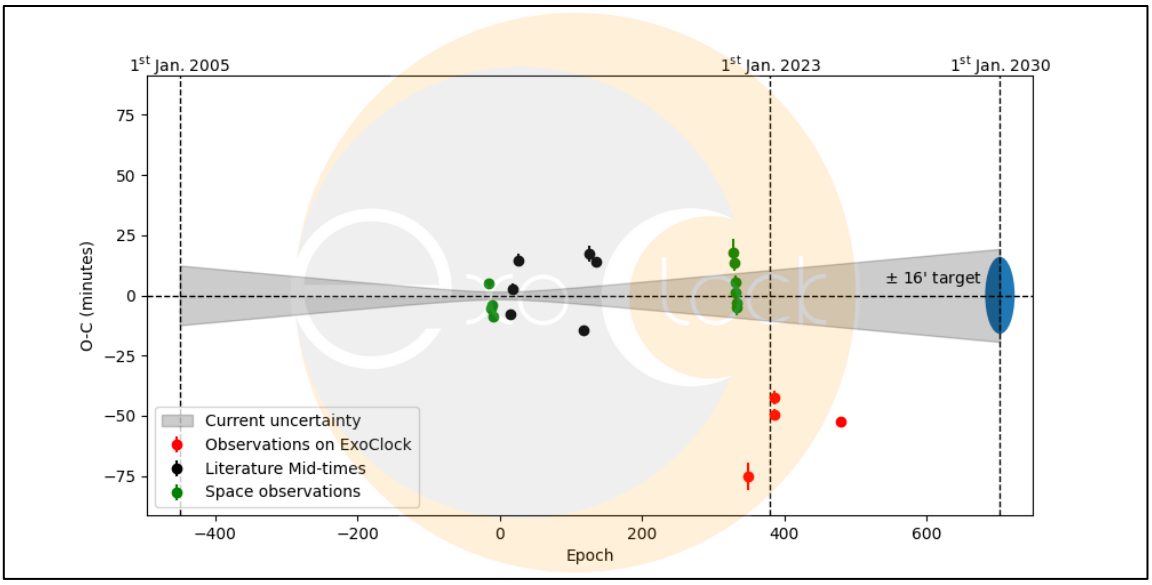


ExoClock database

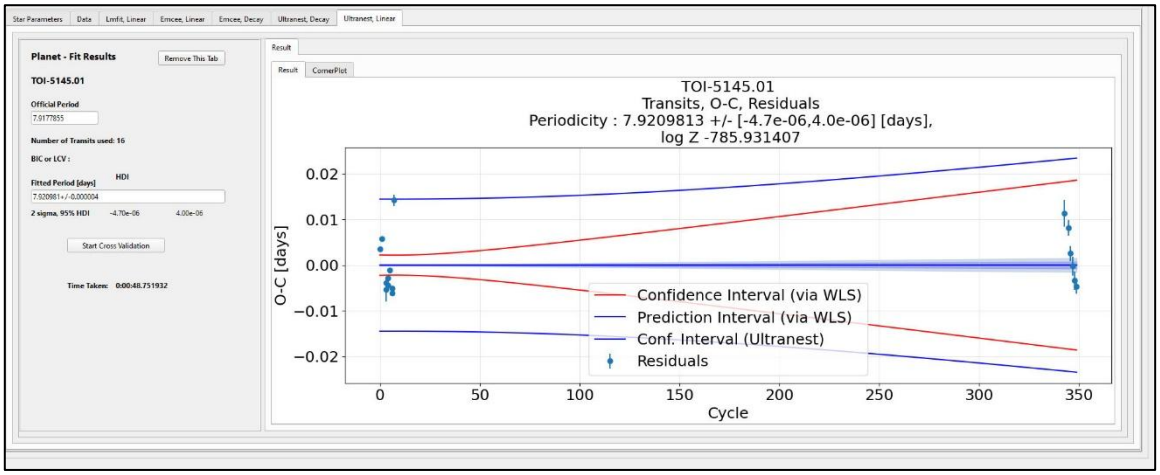


Exoplanetpie analysis suggests a decaying orbit

K2-19b



ExoClock database

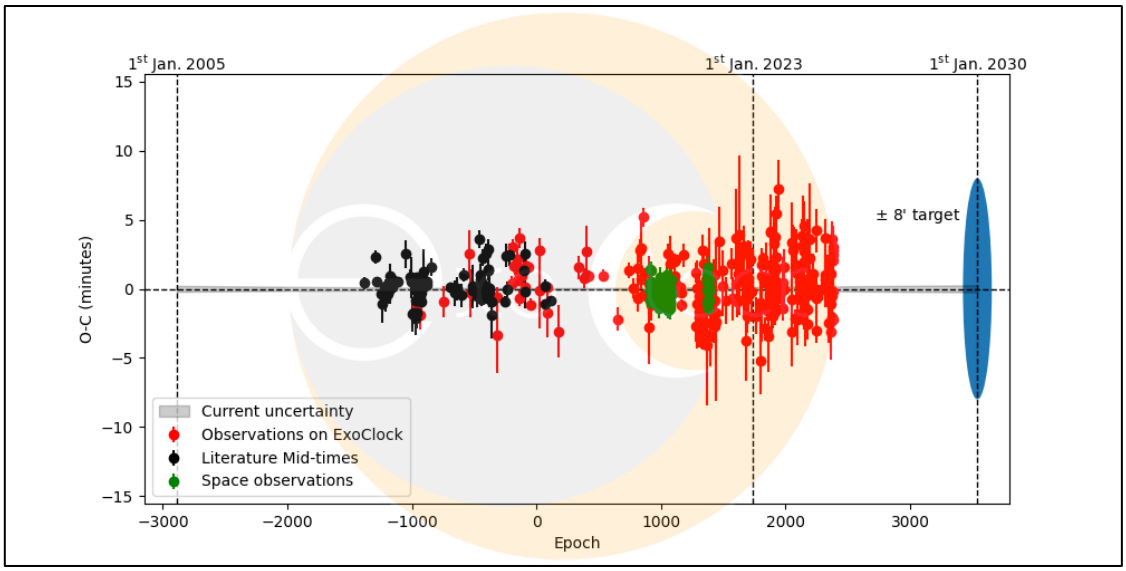


Exoplanetpie

Too little data available to achieve a useful result but suggest we keep this planet under observation – see note below.

Note. K2-19b and c, are a two-planet system of Neptune-sized objects (4.2 and 7.2 R⊕), orbiting a K dwarf extremely close to the 3:2 mean motion resonance. The two planets each show transits, sometimes simultaneously owing to their proximity to resonance and the alignment of conjunctions.

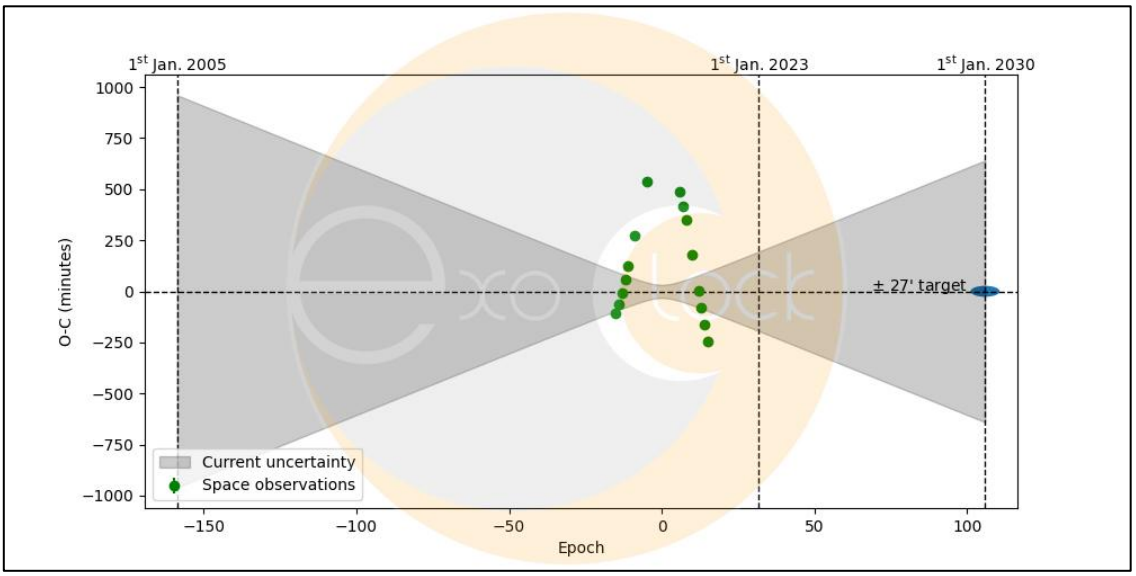
Qatar-1b



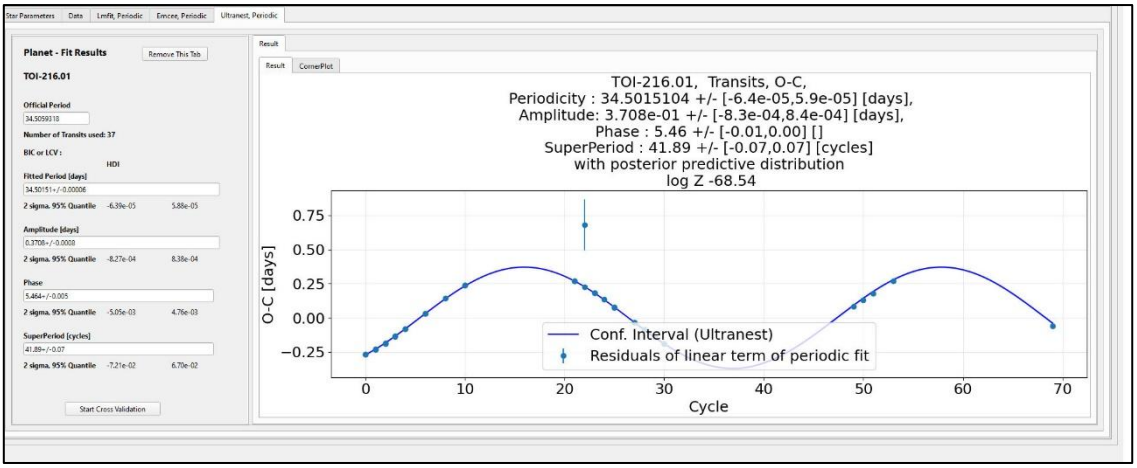
ExoClock database

A paper [Qatar-1: indications for possible transit timing variations] proposes two causes of TTVs - a weak perturber in resonance with Qatar-1b, or by a massive body in the brown dwarf regime. More observations and radial velocity monitoring are required to better constrain the perturber's characteristics.

TOI-216.01



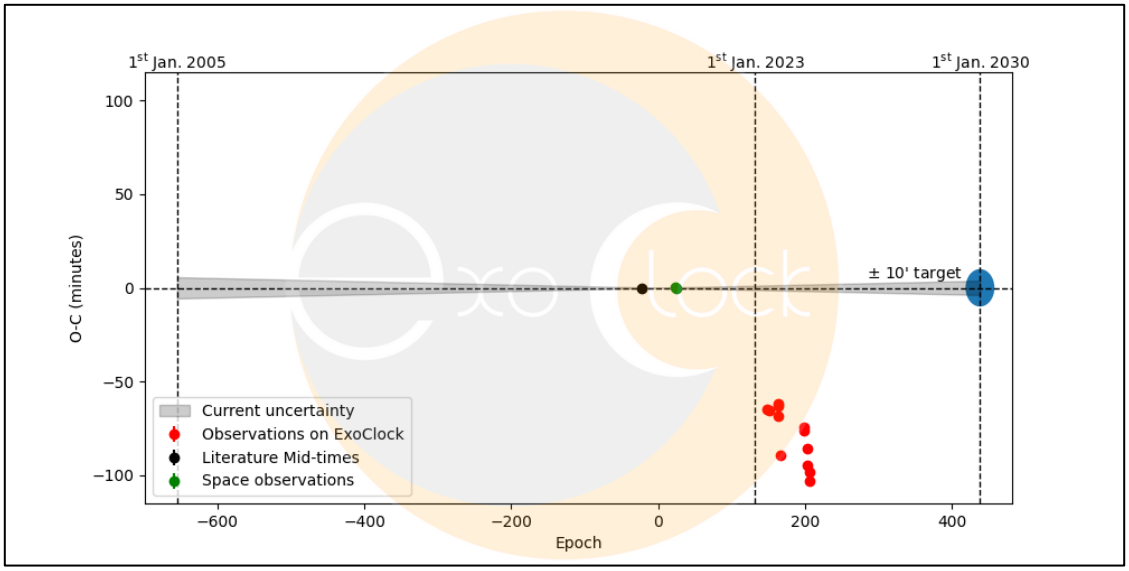
ExoClock database



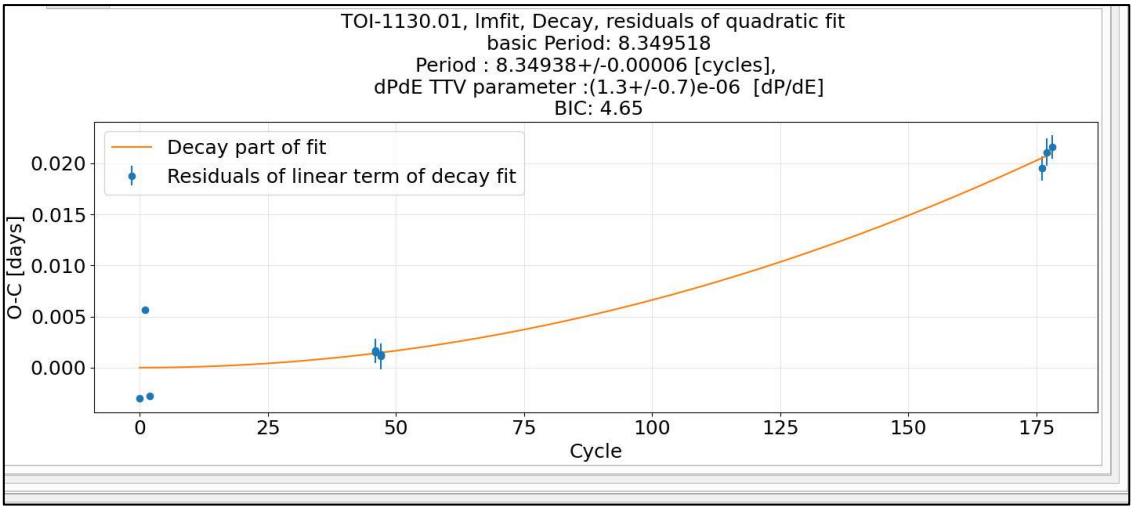
Exoplanetpie

Exoplanetpie analysis indicates the cyclical nature of the transits as does the ExoClock plot. This exoplanet is in a 2:1 resonant orbit with TOI-216.02 - 34.57 and 17.01 days respectively.

TOI-1130c

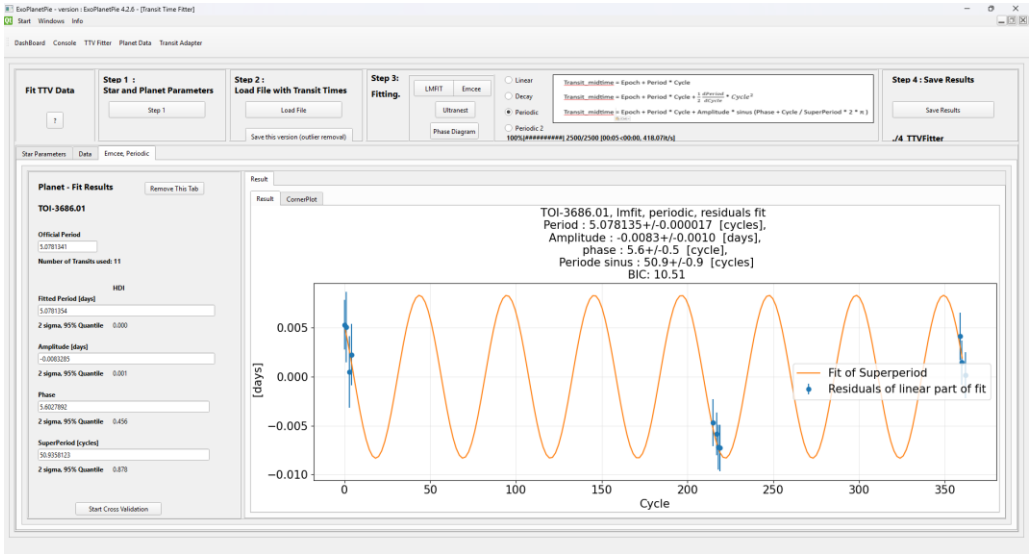


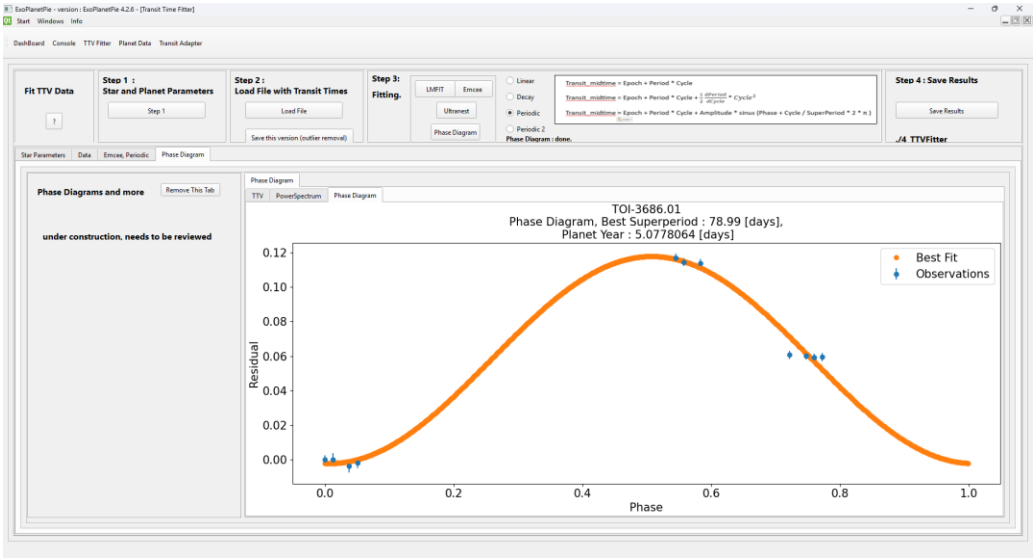
ExoClock database

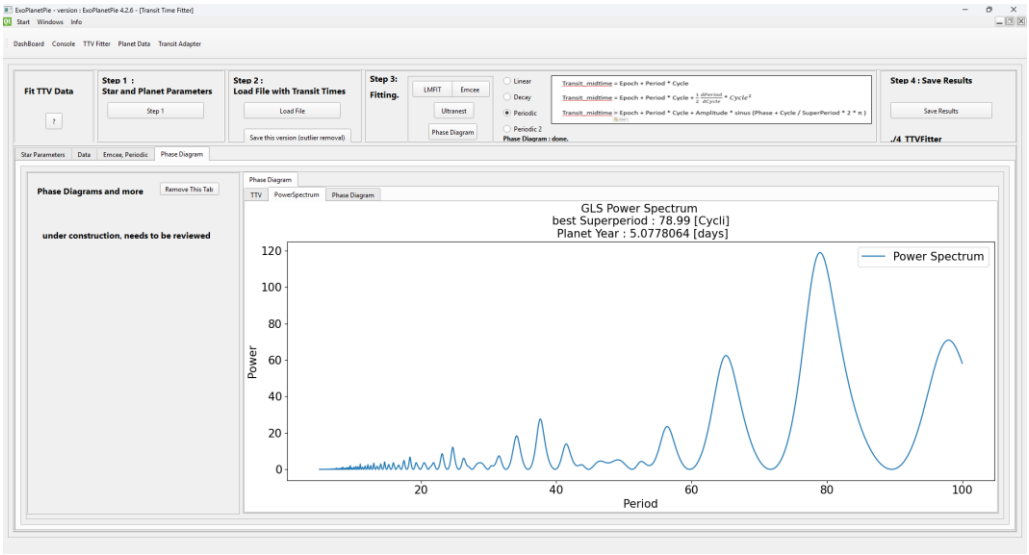


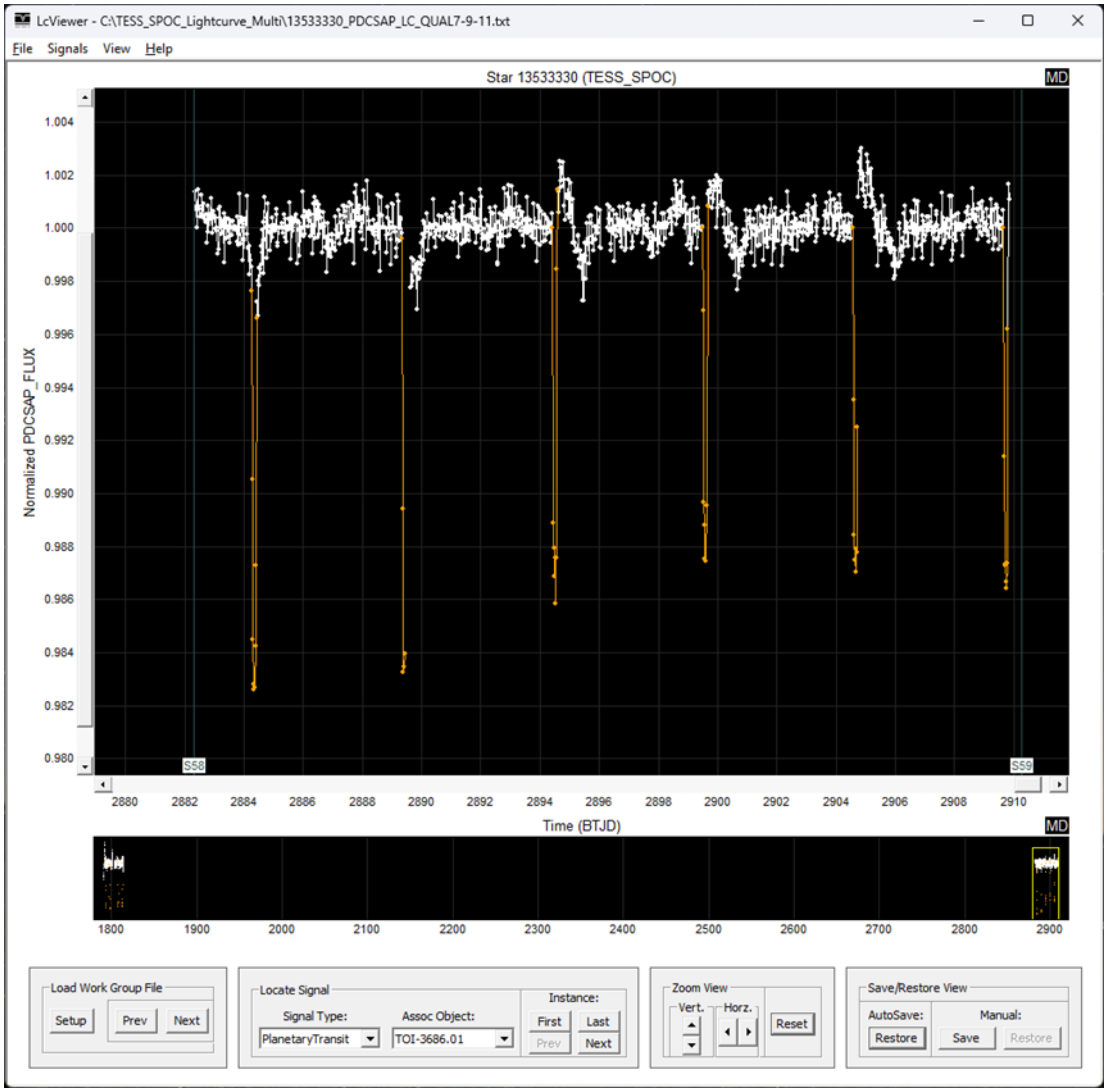
Exoplanetpie analysis -very little data but some indication of an increasing orbital period

TOI-3686.01

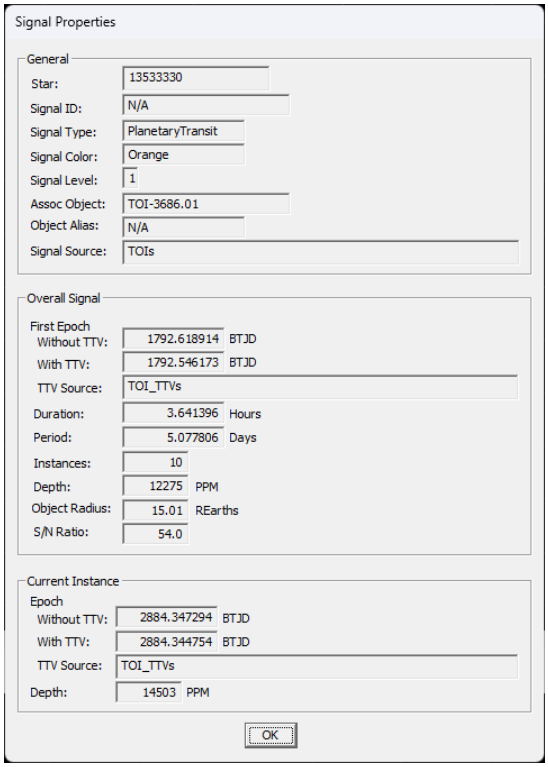




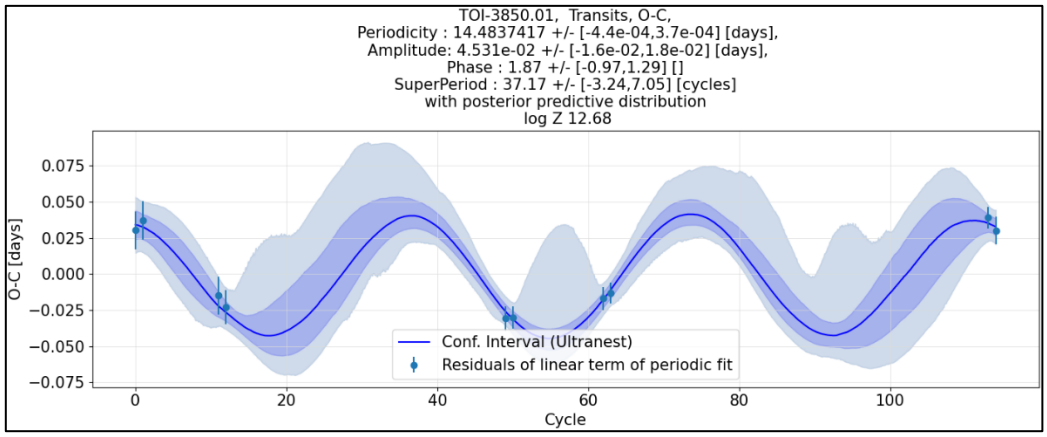


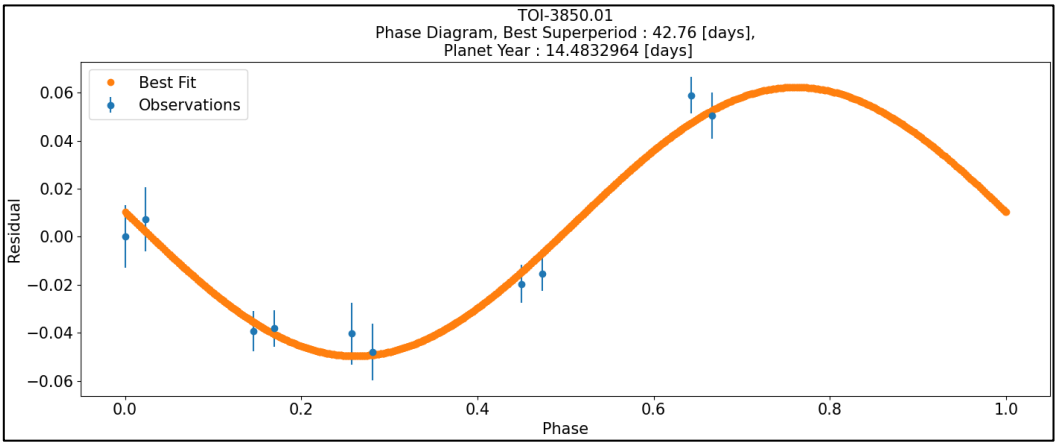


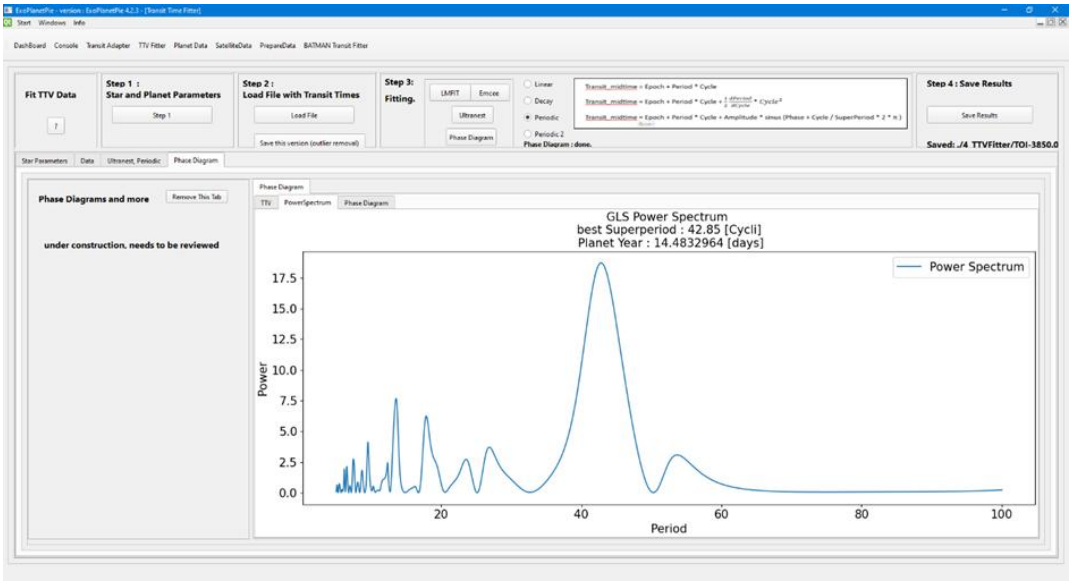
The LcTools plot, above, suggests that the transit depth is varying in a cyclical manner. There are a number of reasons for this including; starspots, changes in orbital inclination, planetary shape, orbital precession and exomoons.

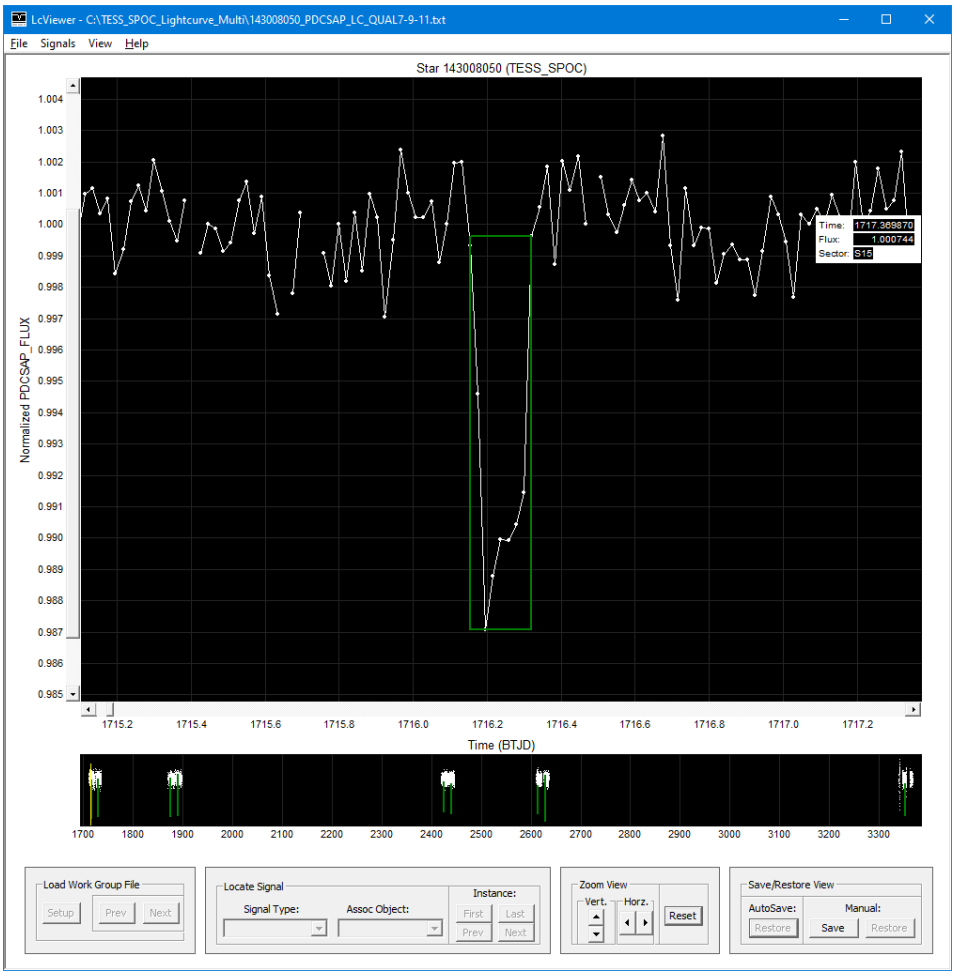

Signal Properties
General
Star: 13533330
Signal ID: N/A
Signal Type: PlanetaryTransit
Signal Color: Orange
Signal Level: 1
Assoc Object: TOI-3686.01
Object Alias: N/A
Signal Source: TOIs
Overall Signal
First Epoch
Without TTV: 1792.618914 BTJD
With TTV: 1792.546173 BTJD
TTV Source: TOI_TTVs
Duration: 3.641396 Hours
Period: 5.077806 Days
Instances: 10
Depth: 12275 PPM
Object Radius: 15.01 REarths
S/N Ratio: 54.0
Current Instance
Epoch
Without TTV: 2884.347294 BTJD
With TTV: 2884.344754 BTJD
TTV Source: TOI_TTVs
Depth: 14503 PPM
OK

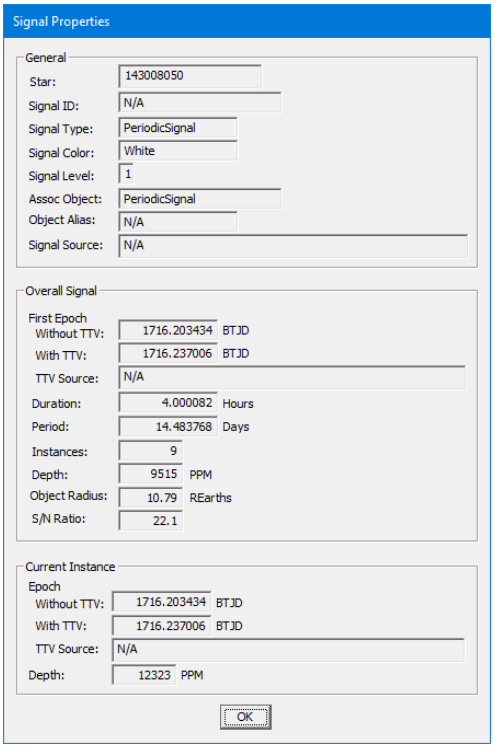
TOI-3850.01


TOI-3850.01, Transits, O-C,
Periodicity : 14.4837417 +/- [-4.4e-04,3.7e-04] [days],
Amplitude: 4.531e-02 +/- [-1.6e-02,1.8e-02] [days],
Phase : 1.87 +/- [-0.97,1.29] []
SuperPeriod : 37.17 +/- [-3.24,7.05] [cycles]
with posterior predictive distribution
log Z 12.68
O-C [days]
Cycle
Conf. Interval (Ultranest)
Residuals of linear term of periodic fit


TOI-3850.01
Phase Diagram, Best Superperiod : 42.76 [days],
Planet Year : 14.4832964 [days]
Best Fit
Observations
Residual
Phase

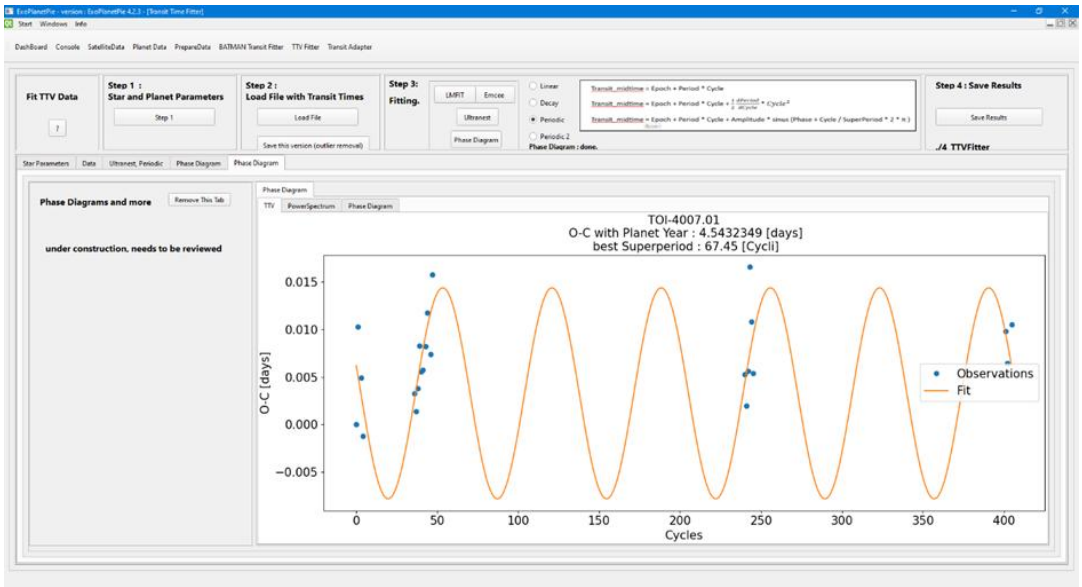

Fit TTV Data
Step 1 :
Star and Planet Parameters
Step 2 :
Load File with Transit Times
Step 3:
Fitting.
Step 4 : Save Results
Phase Diagrams and more
under construction, needs to be reviewed
GLS Power Spectrum
best Superperiod : 42.85 [Cycli]
Planet Year : 14.4832964 [days]
Power Spectrum
Power
Period

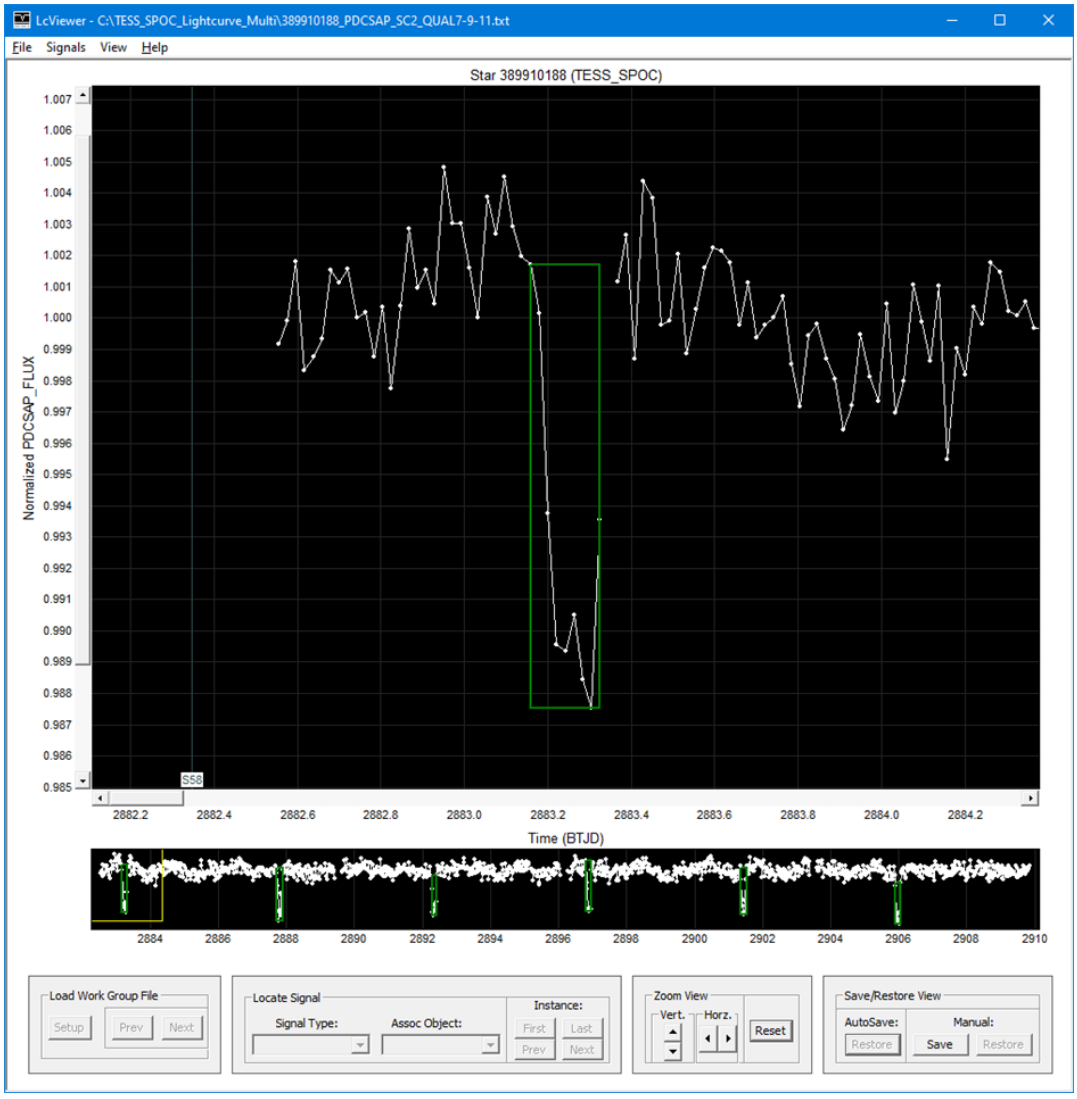

LcViewer - C:\TESS_SPOC_Lightcurve_Multi\143008050_PDCSAP_LC_QUAL7-9-11.txt
File Signals View Help
Star 143008050 (TESS_SPOC)
Normalized PDCSAP_FLUX
Time: 1717.389870
Flux: 1.000744
Sector: S15
Time (BTJD)
Load Work Group File
Setup Prev Next
Locate Signal
Signal Type:
Assoc Object:
Instance:
First Last
Prev Next
Zoom View
Vert. Horz.
Reset
Save/Restore View
AutoSave:
Manual:
Restore Save Restore



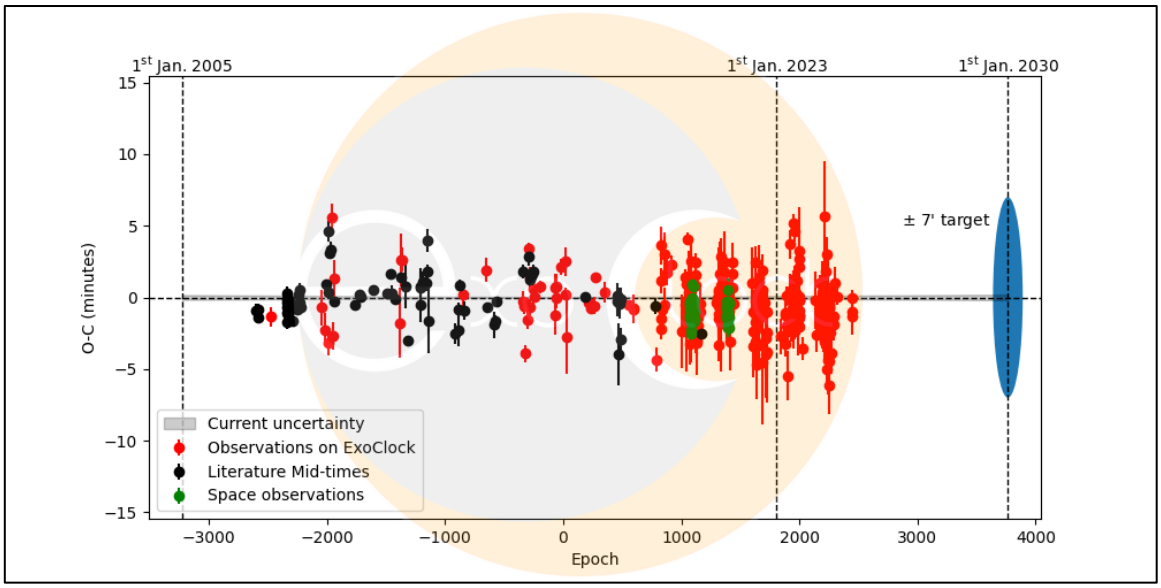
Both Exoplanetpie and LcTools indicate TTVs with a superperiod of 42.76 days.

TOI-4007.01

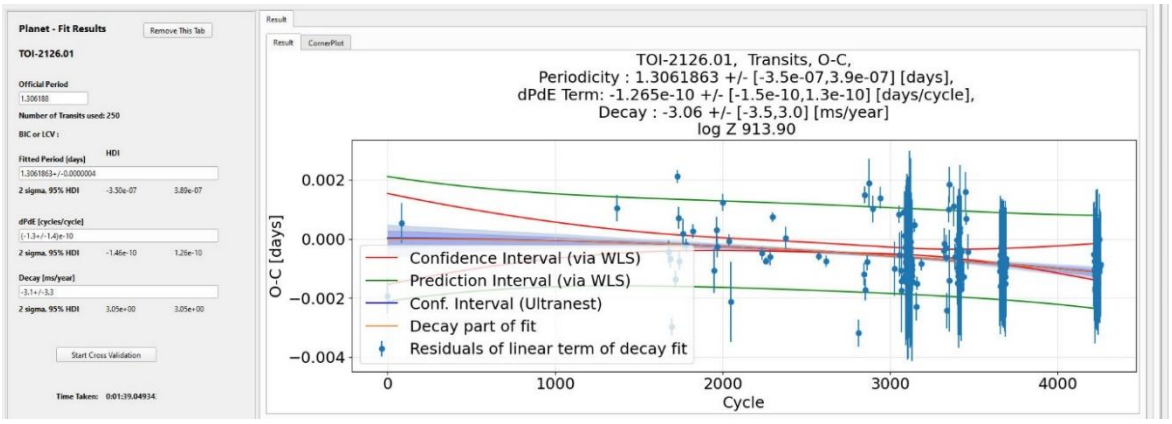



LcViewer - C:\TESS_SPOC_Lightcurve_Multi\389910188_PDCSAP_SC2_QUAL7-9-11.txt
File Signals View Help
Star 389910188 (TESS_SPOC)
Normalized PDCSAP_FLUX
1.007 1.006 1.005 1.004 1.003 1.002 1.001 1.000 0.999 0.998 0.997 0.996 0.995 0.994 0.993 0.992 0.991 0.990 0.989 0.988 0.987 0.986 0.985
SS8
2882.2 2882.4 2882.6 2882.8 2883.0 2883.2 2883.4 2883.6 2883.8 2884.0 2884.2
Time (BTJD)
2884 2886 2888 2890 2892 2894 2896 2898 2900 2902 2904 2906 2908 2910
Load Work Group File
Setup Prev Next
Locate Signal
Signal Type:
Assoc Object:
Instance:
First Last
Prev Next
Zoom View
Vert.
Horz.
Reset
Save/Restore View
AutoSave:
Manual:
Restore
Save
Restore

TrES-3b

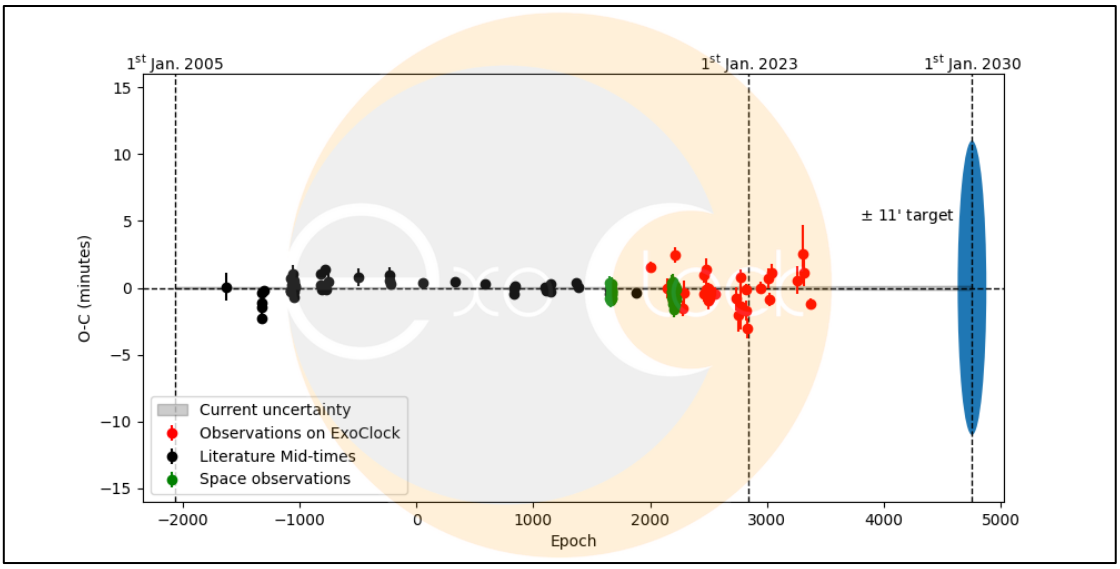


ExoClock database

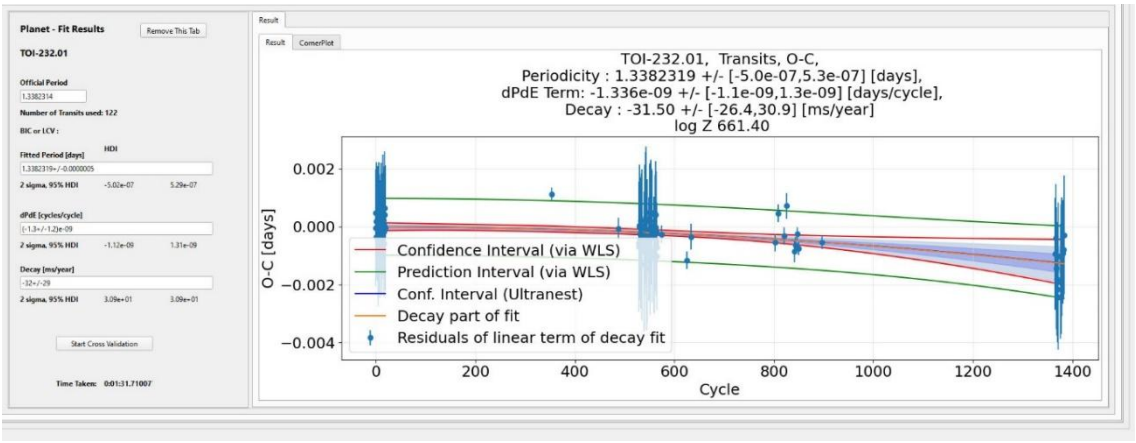


Exoplanetpie analysis suggests a decaying orbit

WASP-4b



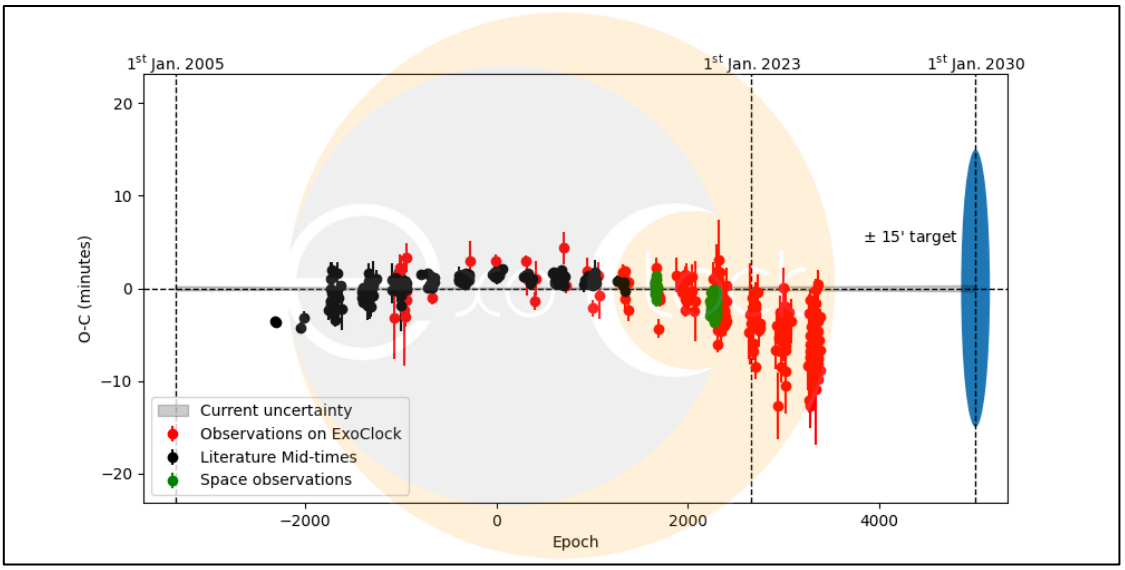
ExoClock database



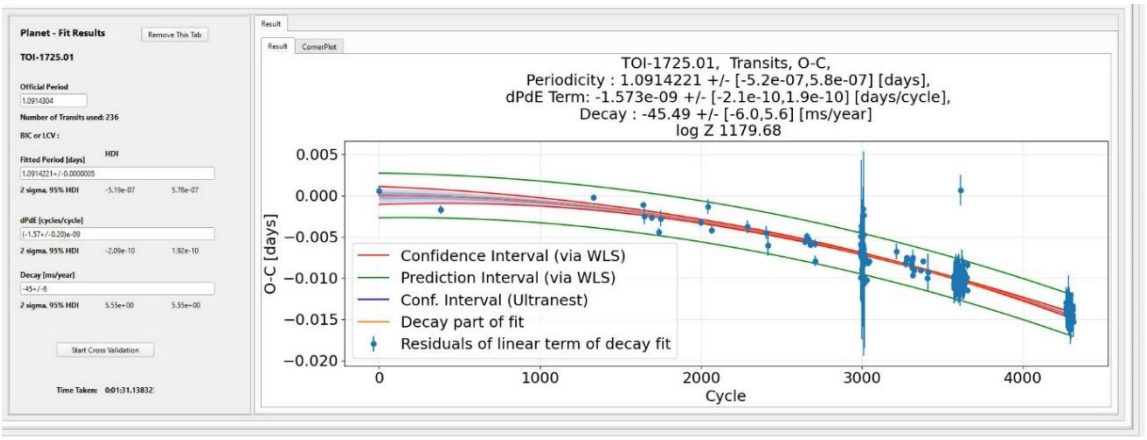
Exoplanetpie analysis suggests a decaying orbit which is confirmed in a paper

[The orbit of WASP-4 b is in decay]

WASP-12b



ExoClock database



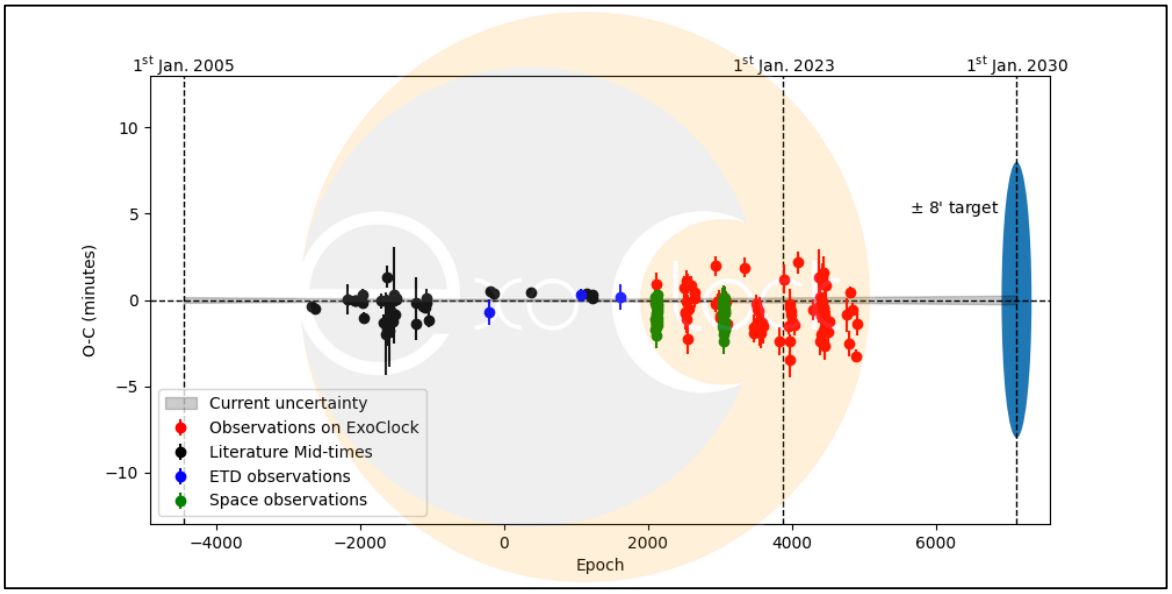
Exoplanetpie analysis indicates a decaying orbit but earlier ExoClock data might indicate a precessing eccentric orbit

Study reveals mystery of decaying planetary orbits

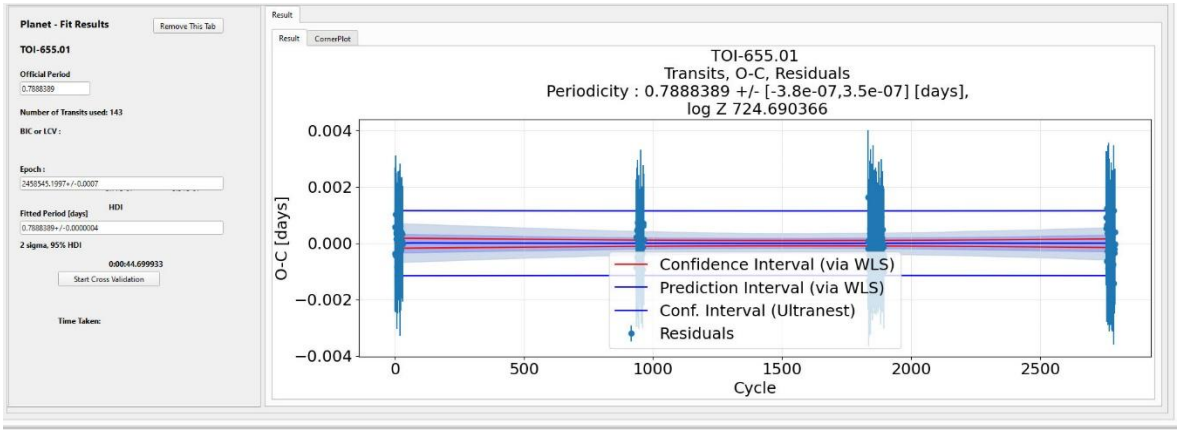
The study, published Mon April 29 2025 in The Astrophysical Journal Letters, proposes that stellar magnetic fields play a crucial role in dissipating the gravitational tides responsible for the orbital decay of ‘hot Jupiter’ exoplanets.

Quote from the above link – ‘At the moment, the only planet we know for certain to be spiralling into its star - and in the far future, possibly being destroyed - is WASP-12b’.

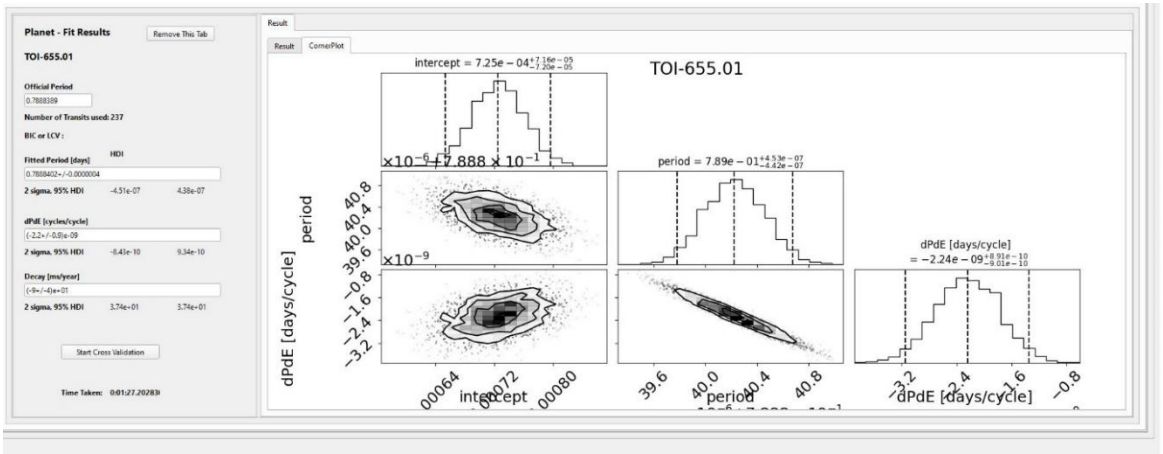
WASP-19b



ExoClock database



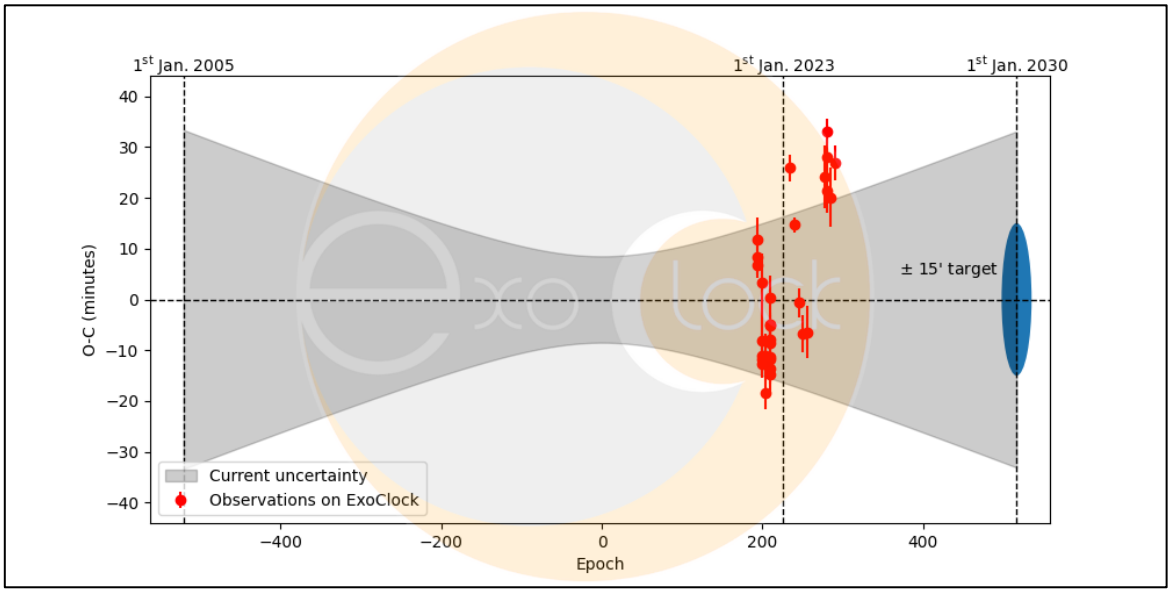
Exoplanetpie analysis indicates a stable orbit



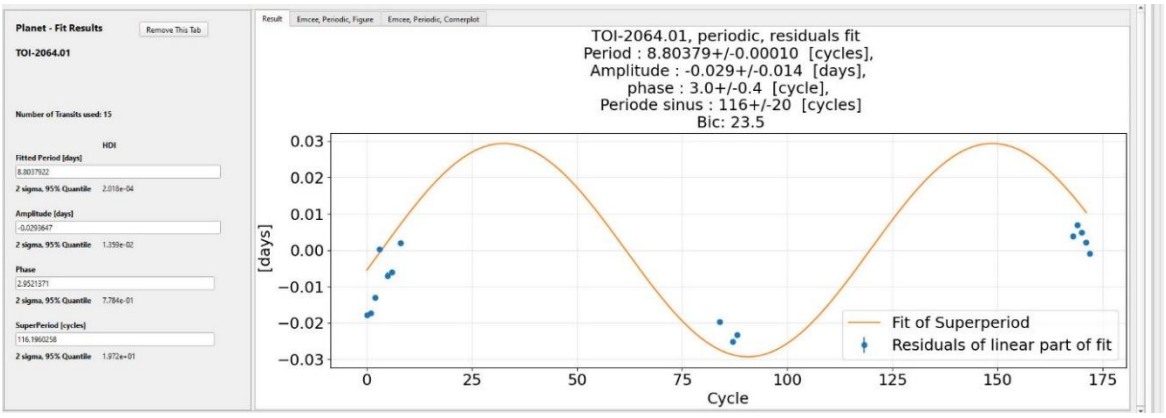
A paper [Investigating Transit Timing Variations in the Ultra-short Period Exoplanet WASP-19b] states ‘Subsequent frequency analysis and sinusoidal model fitting indicate that the observed TTVs are more consistently explained by apsidal

precession of WASP-19b's orbit. Our findings suggest that stellar magnetic activity, potentially linked to the Applegate mechanism, may also contribute to the observed timing variations. **To further constrain the origin of the TTVs and assess the contributions of these mechanisms, continued high-precision photometric monitoring of the WASP-19 system is strongly recommended'**.

WASP-148b



ExoClock database



Exoplanetpie analysis – indication of a periodic variation but more results needed

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