Issue 37 – May 17, 2023

ExoClock Newsletter

Dear ExoClock participants,

Hope you are all doing well!

We would like to welcome the new members!

We send out a newsletter like this at the beginning of every month, while you can read the past newsletters, watch the past meetings, and have access to other educational material at:

www.exoclock.space/users/material

***We also organise meetings dedicated to new ExoClock members**. These meetings are held just after our regular monthly meeting. The beginner's meeting is usually held on the Friday after our regular meeting or the week after. In these meetings, newcomers have the opportunity to ask questions of any level related to the operation of the website, observations of transits, data analysis etc. Note that these meetings are not recorded.*

*Finally, **we have a Slack channel** for more direct communication and if you want to join, follow this link:*

https://join.slack.com/t/exoclock/shared_invite/zt-1t5l875v6-x0s8s553kT8nbCvbyo7boA

In this newsletter, we discuss:

1. **Announcements**
   - **1.1. Stellar Monitoring working group**
   - **1.2. New monthly meetings on HOPS technical issues**
   - **1.3. 3rd ExoClock annual meeting**
   - **1.4. Ariel Data Challenge 2023**
   - **1.5. Google Calendar for meetings and observing calls**
2. **Observing campaigns**
3. **Highlighted Observations**
4. **New series of articles: Featuring WASP-12b**

1. Announcements

1.1 Stellar Monitoring working group

A new activity that we plan to start as part of ExoClock, in collaboration with the Stellar Characterisation working group of the Ariel consortium, is the monitoring of the stars that host Ariel candidates. This is important to understand the level of activity that these stars have and also to determine their rotational periods. For this exercise we need to observe the star out of transit for about one hour every few days/weeks for a long period of time, usually of the order of months. We will start with a pilot this summer, as the nights are getting shorter and shorter!

The stars that we plan to follow are:

- TOI-1259A: https://www.exoclock.space/database/planets/TOI-1259Ab/
- HAT-P-23: https://www.exoclock.space/database/planets/HAT-P-23b/
- HAT-P-4: https://www.exoclock.space/database/planets/HAT-P-4b/
- KELT-8: https://www.exoclock.space/database/planets/KELT-8b/

The activity will start on the 1st of June and if you have a telescope in the northern hemisphere and a Cousins R or Johnsons V filter, you are still welcome to join, by filling this form:

https://forms.gle/cbphUqjQpbsgEgKL6

More details will be sent to the interested observers next week via e-mail and Slack.

1.2 HOPS updates and new monthly meeting on HOPS

Recently we held our first monthly meeting dedicated to HOPS and technical issues. Thanks everyone for your active participation, the meeting was very productive!
The meeting will continue on a monthly basis, and it will help us answer your questions more efficiently, receive your feedback on HOPS and plan for the next updates.

If you have any **questions or suggestions on HOPS** that you want to discuss you can post them on the relevant **Slack channels** before the next meeting!

1.3 3rd ExoClock annual meeting

Thank you everyone for giving us your opinion about our next ExoClock annual meeting! According to the survey, the dates of the **20th and 21st of October** are the most convenient. Although all three candidate locations received very similar votes, **Thessaloniki in Greece** seems to be a bit higher in your preferences. The meeting will be in a hybrid format. We will do our best to organise the meeting according to these preferences and we will keep you updated. Please mark the dates in your calendars and stay tuned!

1.4 Ariel Data Challenge 2023

Ariel will study the light from each exoplanet's host star after it has travelled through the planet's atmosphere in what is known as a spectrum. The information from these spectra can help scientists

investigate the chemical makeup of the planet's atmosphere and discover more about these planets and how they formed. Scientists involved in the Ariel mission need a new method to interpret these data. Advanced machine learning techniques could help them to understand the impact of different atmospheric phenomena on the observed spectrum.

Key information about the challenge:

- Started: **14th April 2023**
- Ends: **18th June 2023**
- Prize: **Sponsored Ticket to ECML-PKDD or Cash Prize for top 3 winners and Invited Talk at the Ariel consortium meeting and other research institutes and Conference Proceedings for top 3 winners.**
- HPC resources: **Free GPU computing resources for participants!**

Interested? Join here:

https://www.ariel-datachallenge.space/

1.5 Google Calendar for meetings and observing calls

After suggestions by participants, we created two Google calendars where you can see all the ExoClock meetings and campaigns.

Meetings:

https://calendar.google.com/calendar/u/1?cid=NGVmMmUzM2YxNTg2MzE1N2Y5MzdlOTczZTgwNGZmZWRkOTcyOTVlYTMyODQ2MzFhMjBhNGE0MmY0MTI4ZDljN0Bncm91cC5jYWxlbmRhci5nb29nbGUuY29t

Observing calls:

https://calendar.google.com/calendar/u/1?cid=MzU4YTFiMGJhZjllMzg4ZTdlMWJhMGIzMGQwOTZlYjVlZWZiY2ZmNzY1MjJlNTYyZWQzZTY1MThmMDFlNWY5OUBncm91cC5jYWxlbmRhci5nb29nbGUuY29t

Note that this month's meeting will be happening on Thursday **the 25th of May at 17:00 BST** instead of the usual time (16:00 BST) as we have the National UK Ariel meeting on the same day.

2. Observing campaigns

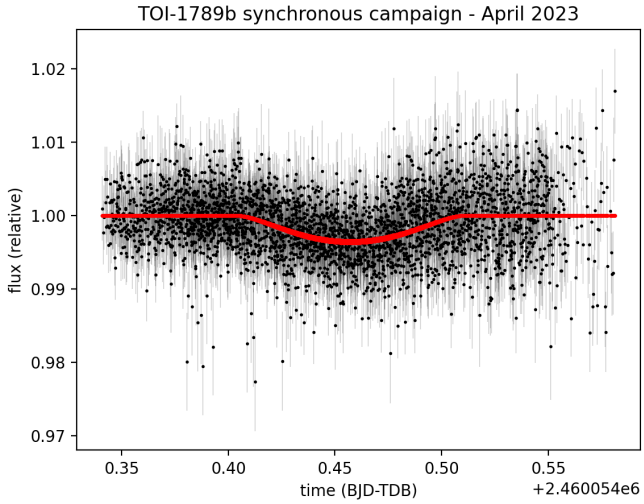
Our most recent campaigns were for two TOI planets: **TOI-2076b** and **TOI-1789b.** For **TOI-2076b** the weather was not good and hence we did not get any observations, but for **TOI-1789b** however we received **12 observations (+1 more from earlier in April)**! Congratulations to all the participants!

We are happy to present here a preliminary combined analysis of all these observations. The observations correspond to a total of **41.5 observing hours** that achieved an **SNR of 1.55×10^4 on the star,** equivalent to an ExoClock-average telescope of **42.0 inches**. Furthermore, the combined fit resulted in a **transit SNR of 20.2**, equivalent to an ExoClock-average telescope of **36.1 inches, and**

better than a single TESS observation (~13) !. The above mean that we achieved **86% efficiency** in combining the observations!

The final fitting results gave:

- **Rp/Rs = 0.0847 ± 0.0024**
  This is deeper than all the TESS data combined (0.06601 ± 0.00063). One possibility is that there are blended nearby stars that make the TESS Rp/Rs to appear lower that it should be (TOI-1789b has a bright nearby star in the field of view).
- **O-C = -7.1 ± 2.0 minutes**
  This is very interesting and means that we will need to continue observing this planet as its ephemeris may be drifting!



Thanks again to: **Richard Abraham, Matthieu Bachschmidt, Leon Bewersdorff, Martin Crow, Stephen Futcher, Kevin Johnson (×2), Adrian Jones, Daniel Kustrin, Eric Miny, Lionel Rousselot, Mark Salisbury, and Marc Serrau** for their observations and **Alessandro Nastasi** for organising the Synchronous observations Working Group!

Our next campaigns are again for two TOI planets: **TOI-2136b** and **TOI-1272b.**

The transit of **TOI-2136b is happening between Saturday, the 20th of May 23:41 UTC and Sunday the 21st of May 03:21 UTC.**

The transit of **TOI-1272b is happening between Saturday the 27th of May 21:36 UTC and Sunday the 28th of April 01:10 UTC.**

These transit events will be included in your google calendar so keep an eye if you are interested in observing them! If you have a telescope between 8 and 14 inches, you can give it a try and observe those transits. Note that these transits will NOT appear in your scheduler so you will need to organise your observation yourselves. You can check the ExoworldsSpies scheduler to see if the transit is observable from your location (you should use a telescope aperture of **30 inches**, otherwise the planet will not appear):

https://www.exoworldsspies.com/en/scheduler/

Remember that the exposure time should be longer than your overheads (dead time between

exposures). To be able to have a decent exposure time you may need to use a filter -preferably Red Cousins- or to defocus your telescope.

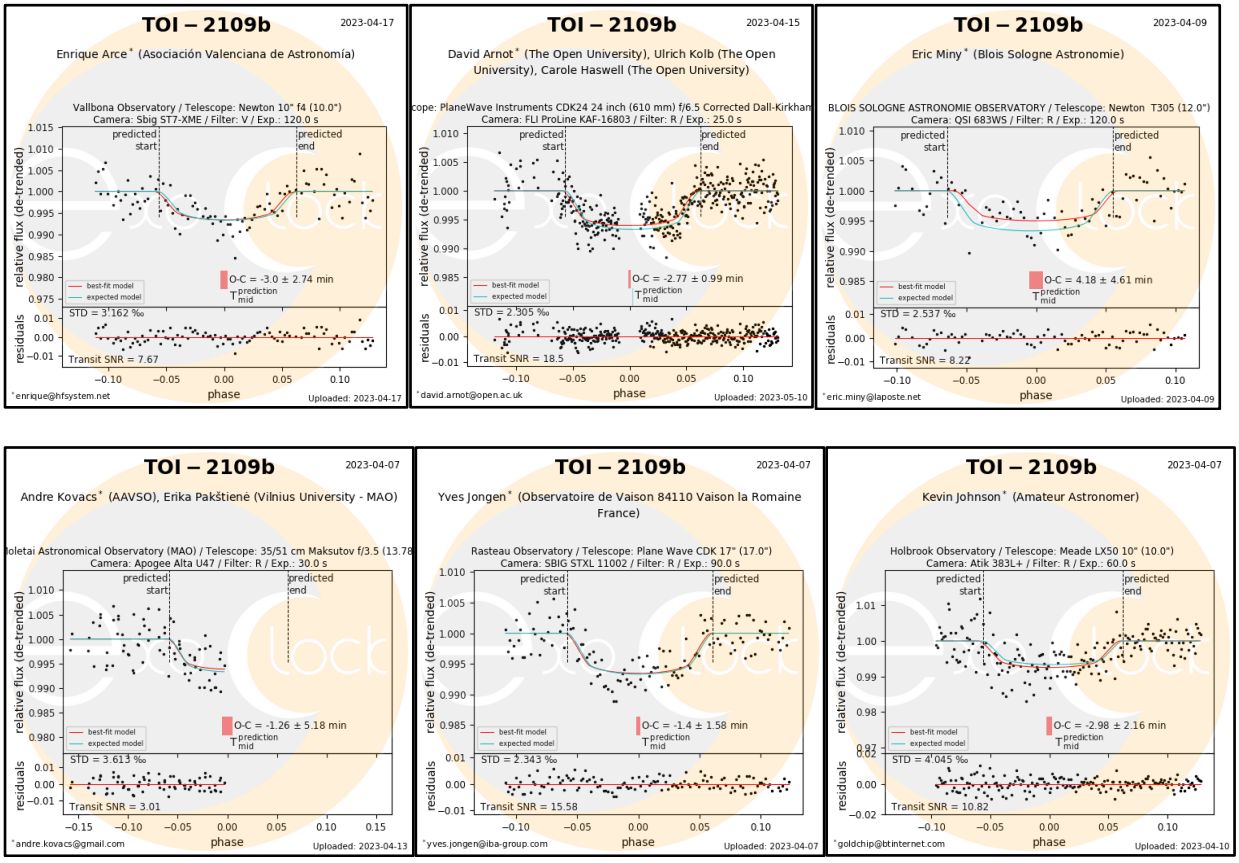
You wouldn't need to do anything special in terms of the analysis, just upload the observations to ExoClock in the normal fashion. Please indicate in the comment section that the observation is *"part of the synchronous observations campaign"*.

3. Highlighted Observations

We would like to thank you all for the observations you contributed to the previous months!

We have selected **TOI-2109b**, a target that has been flagged as **HIGH** priority. In April there were five observations by **Kevin Johnson, David Arnot (and team), Andre Kovacs, Yves Jongen, Eric Miny and Enrique Arce.** Thanks to your observations the target has been marked now as **LOW** priority!

Thank you all for your observations and congratulations!



4. New series of articles: "Exoplanet CV"

We are happy to start a new activity to enrich your background knowledge on some of the Ariel candidates. These articles will be featuring one exoplanet each month and will be written by our literature team. We start with a very famous planet, **WASP-12b** (article attached in the next page). Enjoy!

Clear Skies,
the ExoClock team

"CV" of WASP-12b

by Chrysostomos Sidiropoulos (University of Ioannina, Greece), ExoClock literature team member

WASP-12b is a transiting hot Jupiter orbiting around an F star which is evolving off the zero-age main sequence. It was discovered in 2008 by Hebb et al. It has a period of 1.09 days, and it has a peculiar egg-shape due to the strong gravitational forces from the host star (Li et al. 2010, **Figure 1**).

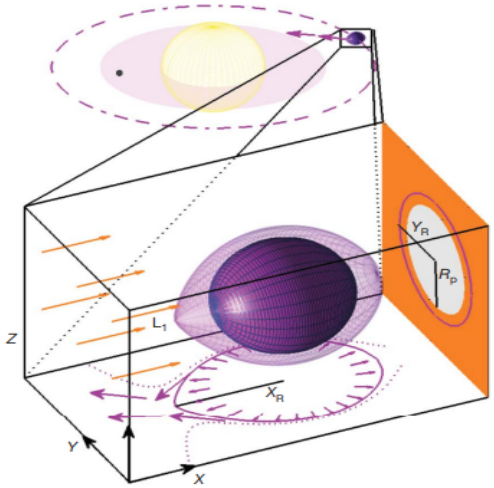


Figure 1: The egg-shape of WASP-12b due to the strong gravitational forces from the host star (Li et al. 2010).

WASP-12b orbits only one stellar diameter away from the photosphere of its host star (Hebb et al. 2009). This means that the planet is orbiting within the star's corona, and this is the reason why the planet is heavily irradiated. In addition, the proximity to its host star is the reason for the extreme conditions in its atmosphere. **WASP-12b** has an equilibrium temperature of 2516 K. Its atmosphere contains H, He, H_2O, CO_2, CO, CH_4 among other chemical species (Madhusudhan et al. 2011) and it's highly ionized (Fossati et al. 2010)

In the Observed-Calculated (O-C) diagram, the presence of Transit Time Variations (TTVs) is clear (**Figure 2**). Since its discovery, its period is decreasing by 29 ± 2 ms every year (Yee et al. 2020). One proposal is that the decreasing period is a sign of orbital decay (Yee et al. 2020), but the data from previous works suggest that it is possible that the planet has a slightly eccentric orbit and is undergoing apsidal precession (Ragozzine & Wolf 2009). In 2013, Maciejewski et. al suggested the presence of a second planet to explain the TTVs, a theory that has not yet been confirmed yet.

In conclusion, **WASP-12b** is a very interesting planet and further observations and research could provide valuable insight into the dynamics of planetary systems and lead to useful information on how exoplanets form and evolve over time.

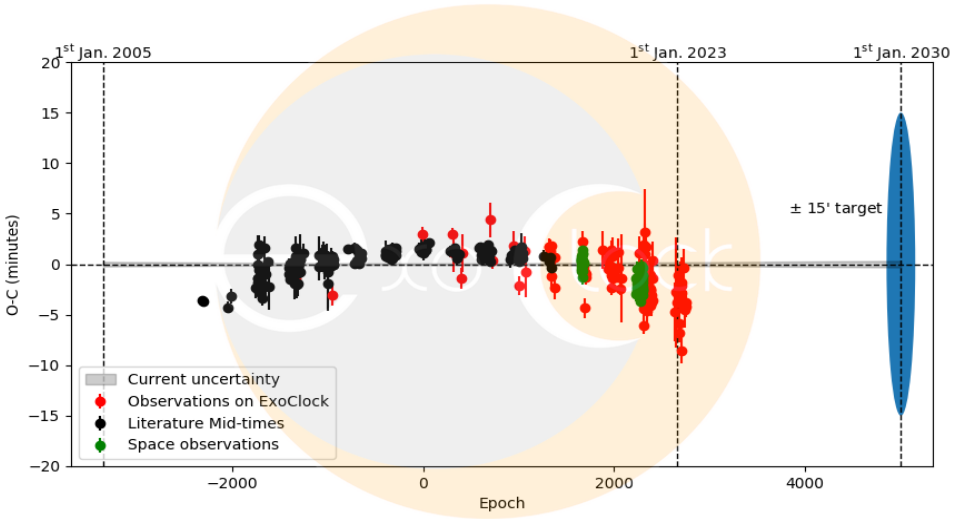


Figure 2: The O-C diagram of WASP-12b from ExoClock.

References:

1. [Collins et al. 2017]
https://ui.adsabs.harvard.edu/abs/2017AJ....153...78C/abstract

2. [Fossati et al. 2010]
https://ui.adsabs.harvard.edu/abs/2010ApJ...720..872F/abstract

3. [Hebb et al. 2009]
https://ui.adsabs.harvard.edu/abs/2009ApJ...693.1920H/abstract

4. [Li et al. 2010]
https://ui.adsabs.harvard.edu/abs/2010Natur.463.1054L/abstract

5. [Maciejewski et al. 2013]
https://ui.adsabs.harvard.edu/abs/2013A%26A...551A.108M/abstract

6. [Maciejewski et al. 2018]
https://ui.adsabs.harvard.edu/abs/2018AcA....68..371M/abstract

7. [Madhusudhan et al. 2011]
https://ui.adsabs.harvard.edu/abs/2011Natur.469...64M/abstract

8. [Ragozzine and Wolf 2009]
https://ui.adsabs.harvard.edu/abs/2009ApJ...698.1778R/abstract

9. [Yee et al. 2020]
https://ui.adsabs.harvard.edu/abs/2020ApJ...888L...5Y/abstract