Issue 24 – Feb 8, 2022

ExoClock Newsletter

Dear ExoClock participants,

Hope you are all doing well! On this January, we have received the most observations (210!) from all other months since the beginning of the project! **Congratulation**s everyone and **many thank**s to our reviewing team for taking the time to review and send feedback to so many observers.

We would like to welcome the new members!

We send out a newsletter like this at the beginning of every month and you 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 on the Friday just after our regular monthly meeting, and they are not recorded. 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.

Finally, we have a Slack channel for more direct communication and if you want to join, please send a request at exoclockproject@gmail.com.

In this newsletter, we discuss:

1. Announcements

1.1 Ariel-related articles

We are starting a new initiative where scientists from the Ariel consortium will be writing articles about different topics of the mission. These articles will be shared every 2-3 months, within this month you will receive the first one. Stay tuned!

1.2 Update on next paper

For the next ExoClock paper there are several groups working on different tasks: The literature group has completed the majority of the tasks which include collecting and reviewing mid-time points from other papers for ExoClock targets. The space data group has started on reviewing data from space telescopes. Finally, the ETD – ExoClock collaboration group started on filtering light curves from ETD which are useful for ExoClock targets. All these will be combined with the ExoClock observations to produce the updated ephemerides.

1.3 Europlanet workshop - 9th to 11th Feb

The Europlanet workshop telescope network science workshop will happen from the **9th to 11th of February**. The second day is dedicated to exoplanets and the ExoClock project will be also presented. Note that this workshop is an excellent opportunity for amateur astronomers that are interested in getting access to equipment to observe transits or other objects.

The registration is free of charge and there is no deadline. The link to register is:
http://mao.tfai.vu.lt/europlanet2022/

1.4 CMOS group update

The CMOS working group presented updates on testing some CMOS detectors. You can access the relevant documents through the CMOS testing campaign page at:

https://www.exoclock.space/cmos_testing_campaign

Your opinion matters! It would be very useful for the CMOS working group to receive some feedback after reading the documents. You can email us your questions and comments here: exoclockproject@gmail.com

2. Observations behind the scenes

In this "Observations behind the scenes" section we discuss about inconsistent O-C results, how do we evaluate them, what can cause them, and how we can solve them.

We find ourselves comparing different fitting results (especially the O-C results) very often:

- We compare O-C results from different photometry runs in HOPS (e.g. when trying the photometry process with different comparison stars)

- We compare O-C results from different fitting runs in HOPS (e.g. when trying the fitting process with different initial parameters or iterations)
- We compare O-C results from a local fit with HOPS and a fit on the website
- We compare O-C results from our observation and other observations of the same planet on the website
- We compare O-C results from multiple observations of the same planet that we have taken.

When we are comparing fitting results we always have to take into account the uncertainties. For example, result A has an O-C = 5.2 ± 1.0, while result B has an O-C = 12.0 ± 8.0. While these two results appear to differ by a large value (12 - 5.2 = 6.8 minutes), the total uncertainty on the difference is larger than that: $\sqrt{5.2^2 + 8.0^2} = 9.5$ minutes, hence the two results are consistent. Generally speaking, differences that are lower or equal to the total uncertainty are unavoidable. Differences that are between one and two times the total uncertainty are expected. Differences that are between two and two times the total uncertainty are worrying but acceptable. Only differences above three times the total uncertainty indicate an inconsistency. In addition, from our experience with ExoClock data, also differences of up to 5 minutes should not worry us, regardless of the uncertainty, as they can be caused by time offsets in our computers and/or cameras, or bad datapoints during the ingress or egress of the transit.

If we have established that we have some inconsistent results, then we can check what is the cause and try to fix it. Let's see some cases:

a. Different photometry runs in HOPS: inconsistencies in this case can arise from problematic comparison stars (variable stars) or systematics (weather instabilities, instrument temperature variations, large drifts on the detector combined with problematic flat fielding). We can avoid such inconsistencies by improving the choice of our comparison stars – non-variables and of similar colour to the target.

b. Different fitting runs in HOPS: inconsistencies in this case can arise from changes in the initial parameters used. We can avoid such inconsistencies by using the initial parameters found on the planets page on the website, e.g.: https://www.exoclock.space/database/planets/TOI-1296b/ .

c. Local fit with HOPS vs fit on the website: inconsistencies in this case can arise from different settings. In particular, on the website the scatter limit is by default 3 (while in HOPS you can change it) and also there are three de-trending methods that you can use (while in HOPS the default de-trending method is the quadrartic one), while on the website the default de-trending method is the airmass. We can avoid such inconsistencies by setting the scatter limit to 3 in HOPS, and by choosing the quadratic de-trending on the website. Note that for the scope of the project, there is no need to run the fitting process locally!

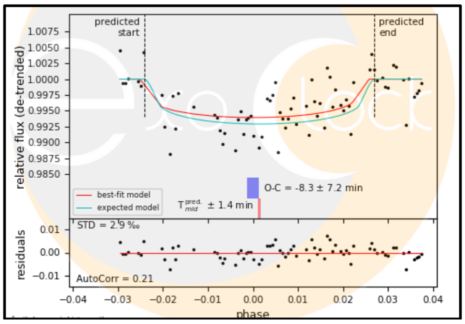
d. My observation vs other observations of the same planet on the website: inconsistencies in this case can arise from problematic comparison stars (variable stars) or systematics (weather instabilities, instrument temperature variations, large drifts on the detector combined with problematic flat fielding). but also, from mistakes in the choice of the time format when you upload a light-curve (e.g. you indicate JD_UTC while your software is giving you HJD_UTC). We can avoid such inconsistencies by improving the choice of our comparison stars – non-variables and of similar colour to the target and by checking the time format we have indicated.

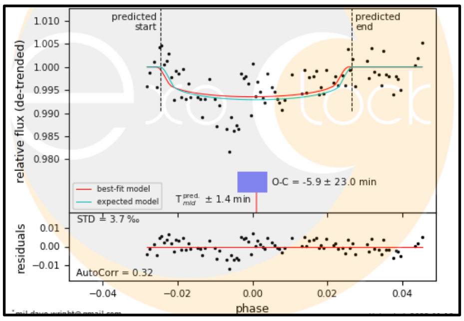
e. Different observation of the same planet with my telescope: same with the previous paragraph!

Below we can see an example from the latest category: two observations of the same planet, TOI-1296 b, taken with the same equipment on two different nights.

From a statistical point of view, the two observations are consistent as the second has a very large uncertainty. But then, how we get so different uncertainties for two observations done with the same instrument under almost identical conditions? If we are careful, we can notice a strange feature at around phase -0.01 in the second observation. Given the shallow depth of this transit, the fitting algorithm can easily get confused, thinking that this is the end of the transit! In the same way that we could also get confused if we did not have the other observation for reference.

Since the source of the problem is the systematics in the light curve, we can try to solve it by changing comparison stars. If we are not successful, then it is better to reject this observation.



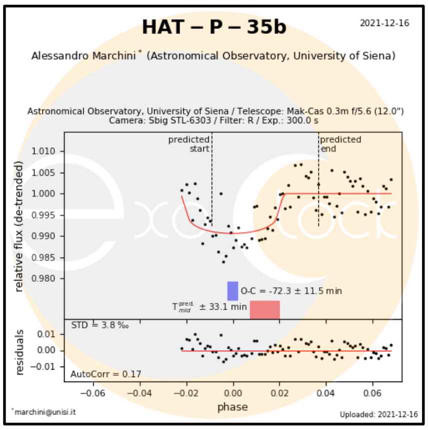


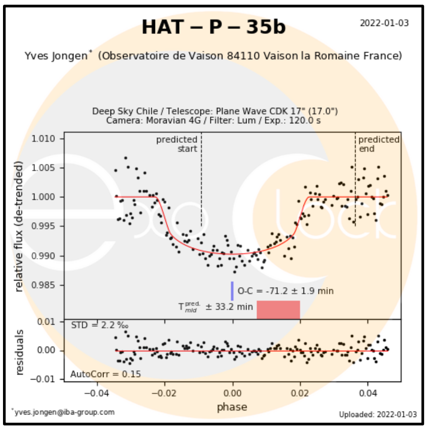
3. Highlighted observations

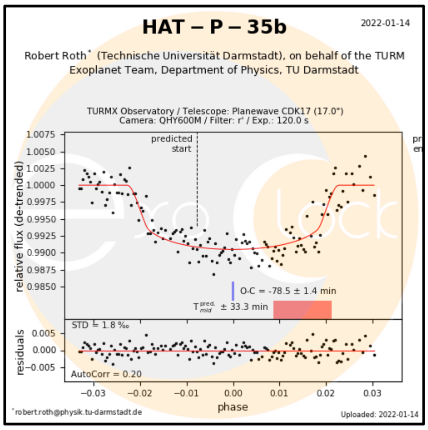
January 2022 has been the busiest month so far, with 210 new and 90 past observations submitted, thank you everyone! We have selected HAT-P-35b, for which a shift of ~72 minutes(!!!) was initially identified by Alessandro Marchini, the 16th of December. This drift was confirmed by two more observations during January by Yves Jongen and Robert Roth.

Below you can see the light-curves.

Congratulations for your efforts!







4. ALERTS

Thank you all for observing the alert targets! Please check your personalised alert schedule at:

www.exoclock.space/schedule/alerts

for the **ALERT** planets and if you get a clear sky and a long-enough night, you can try observing them! The following targets are in the current **alert system**:

- HATS-56b
- KELT-6b
- TOI-628b
- HATS-41b
- TOI-163b
- WASP-183b
- KELT-19Ab
- TOI-905b
- TOI-1296b

We remind you that many targets were not in the alert list, before an unexpected shift was identified by you, the ExoClock participants. This highlights the importance of observing targets that are also of low and medium priorities.

Clear Skies,
the ExoClock team