Follow-up observations of transiting exoplanets with small telescopes

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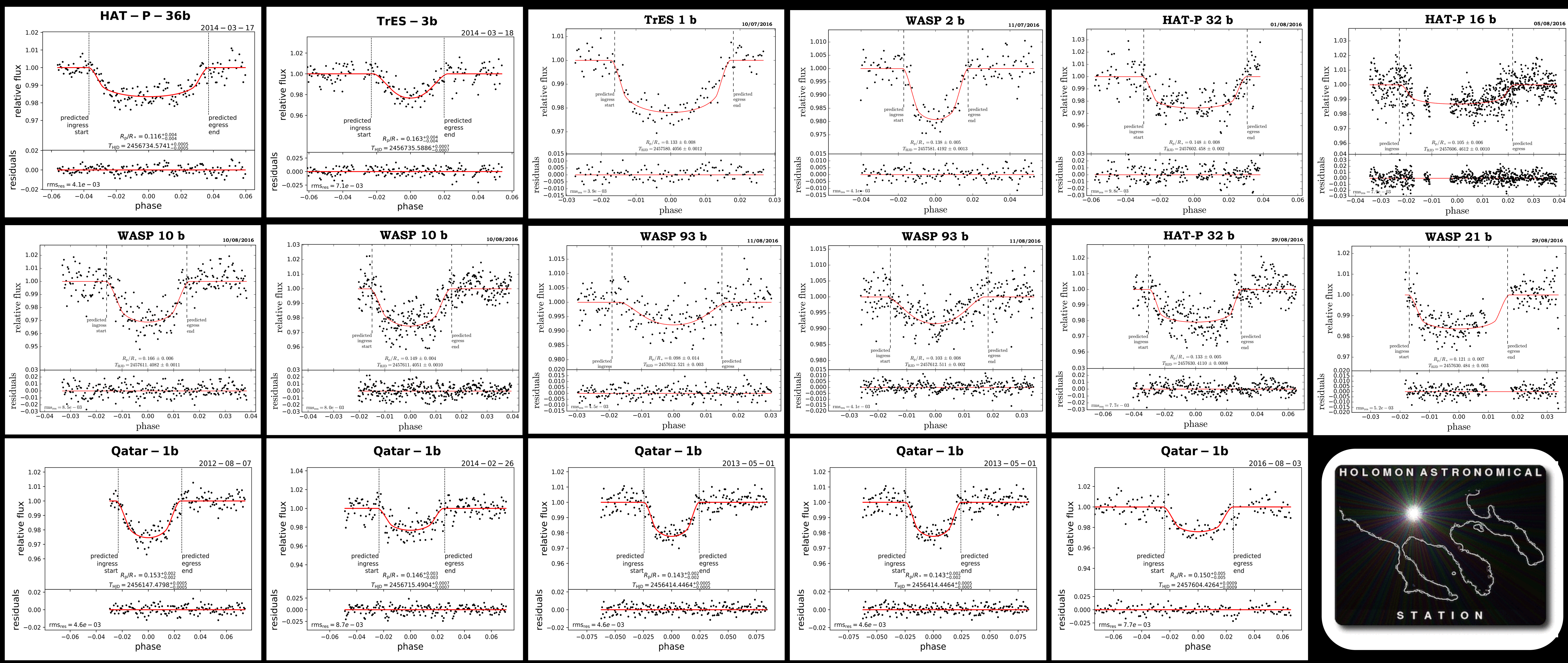
ABSTRACT

Currently the number of exoplanets is rapidly growing, with over 3000 planets discovered. This number is expected to grow even more in the future with dedicated missions like TESS and PLATO, which are expected to find additional 3000 and 10000 planets, respectively. While discovering new exoplanets is still important, we have now entered a new era, where the better characterisation of these plants and their host stars is of extreme importance. A technique that is being used to probe the atmosphere of an exoplanet is transit spectroscopy. During a transit, the stellar and the planetary discs overlap, and while a part of the stellar light is blocked by the core of the planet, another, smaller, part is filtered through its atmosphere. For this technique to be as efficient as possible, we need to have a good knowledge of the orbital parameters of the planets observed. However, the observing time needed to better characterise all the expected exoplanets is not available in large-scale observatories. Consequently, the small and medium-scale telescopes are expected to contribute significantly. We present here the analysis of 32 observations of transiting exoplanets from the Holomon Astronomical Station in Chalkidiki and the Nunki observatory in Skiathos. The data sets were analysed using the Holomon Photometric Software and aim to calibrate the used instruments and also provide new observations of some of the recently discovered exoplanets from the WASP survey.



The main scope of this work was to build a library of transit observations from two locations using different instruments. The two locations are: a) the Holomon Astronomical Station of the Aristotle University of Thessaloniki in Chalkidiki (top), and b) the Nunki observatory on the island of Skiathos (bottom). Such a library can help us to initially test the performance and quality of our observations and subsequently, combine the capabilities of the observatories to follow up and better characterise known exoplnaets.

Series of observations for a particular target: Multiple observations throughout many years (as those of Qatar 1 b from Holomn Astronomical Station) ensure the stability of the measurements over the years and can provide ephemeris updates. Notice the case of WASP 54 b, observed from the Nunki Observatory on the 12th of April 2017, where the transit time is almost 20 minutes before the expected. Such observations on recently discovered planets can help in planning future observations with larger telescopes.

Testing observing techniques: The large number of observations and the stability of the instruments provide the environment for testing optimisation techniques, such as using defocused observations (see WASP 52 b, observed twice from Nunki Observatory on the 5th, focused, and the 26th, defocused, of August 2016).

Cross-calibration between instruments on the Holomon Astronomical Station: Simultaneous observations with different instruments and from different locations offer the opportunity to disentangle systematics, if such exist. WASP 10 b (on the 10th of August 2016) and WASP 93 b (on the 11th of August 2016) were observed with two instruments from Holomon Astronomical Station. The time differences between the two observations is of the level of 2σ and above which indicates that the correalation between timing and systematics is underestimated. We plant to do further such tests in an attempt to improve the precision in timing using better synchronised exposures.

Cross-calibration between Holomon Astronomical Station and Nunki Observatory: Concerning the cross calibration between the two observatories, HAT-P 32 b was observed by both locations on the 1st of August 2016. The time difference was of the order of 0.1σ, thanks to the box-type transit of the planet which allows us to better constrain the ingress and egress of the transit. The R_p/R_* ratio retrieved was also in 1σ agreement, ensuring that observations from both locations can be analysed as supplementary to each other in future experiments. Other parallel (WASP 2 on the 11th of July 2016) and non parallel (TrES 3 b, WASP 10 b) observations of the common targets confirm the above conclusion.