STOKED* with TESS: WASP-77A b

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*STudy Of Known Exoplanet re-Discoveries

Introduction

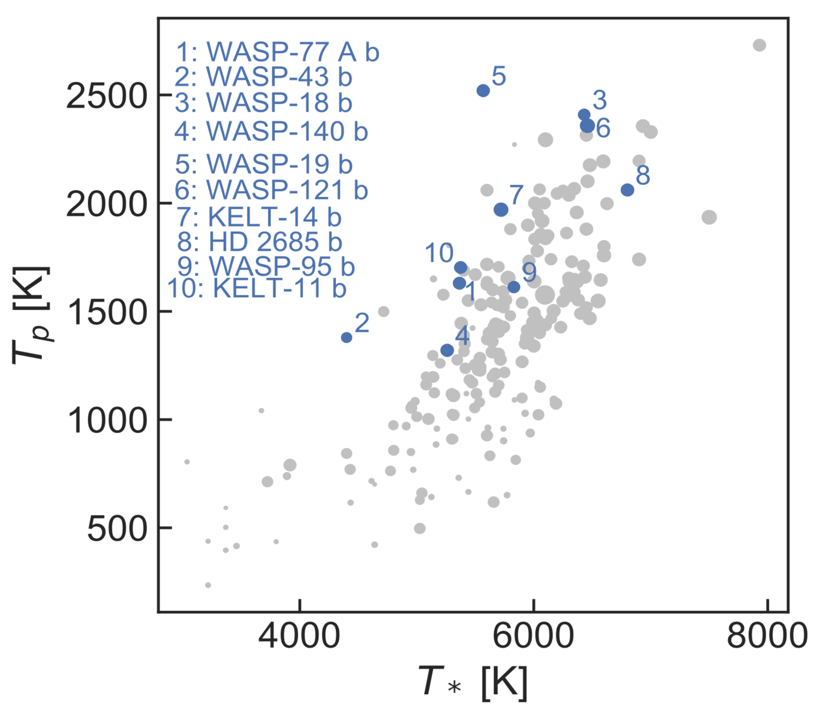

***Figure 1**: Known exoplanets observed by TESS in year 1 graphed for planet equilibrium temperature vs. stellar effective temperature, with the top 10 ESM targets labeled in blue.*

Atmospheric characterization is a major goal of exoplanet research. Promising targets for future observations with the James Webb Space Telescope (JWST) can be selected using the Emission Spectroscopy Metric (ESM):

$$\text{ESM}=\frac{B_{7.5}(T_{day})}{B_{7.5}(T_*)}\times\left(\frac{R_P}{R_*}\right)^2\times 10^{-m_K/5}$$

Here, we focus on **updating the period and epoch of WASP-77A b** in order to predict ideal JWST observation times for atmospheric characterization.

***Figure 2**: Artist rendering of WASP-77A b, a Hot Jupiter and the number 1 ESM target among previously known exoplanets in the TESS year 1 field of view.*

Methodology

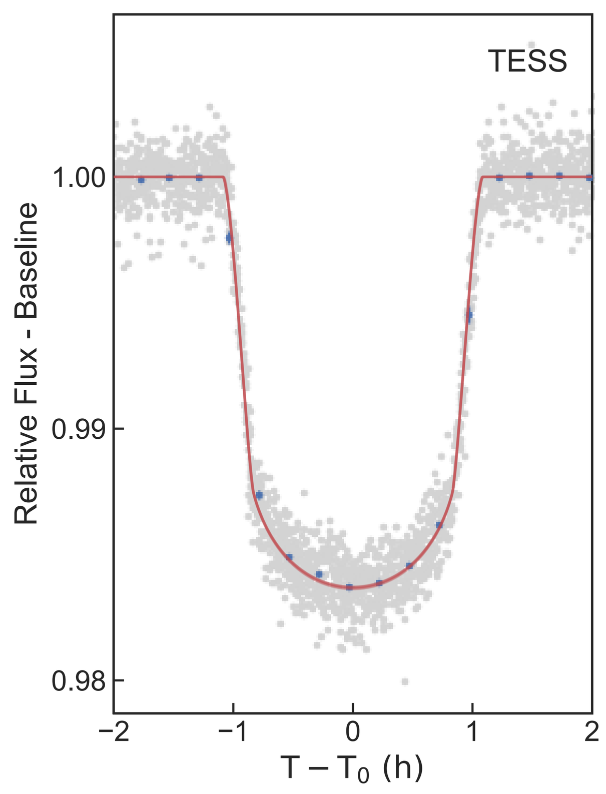

***Figure 3**: Model fit to the photometric data from TESS.*

We utilize the software package **allesfitter** (Günther & Daylan 2019[7]) in order to fit an **appropriate planetary model** to all the gathered data for **WASP-77Ab**. This includes photometric data from WASP-South, EulerCAM, TRAPPIST, Kuiper, and TESS, along with RV data from CORALIE and HARPS[8,9]. We run fits for each instrument individually first to determine the red (systematic) noise, then fit for all astrophysical parameters at once.

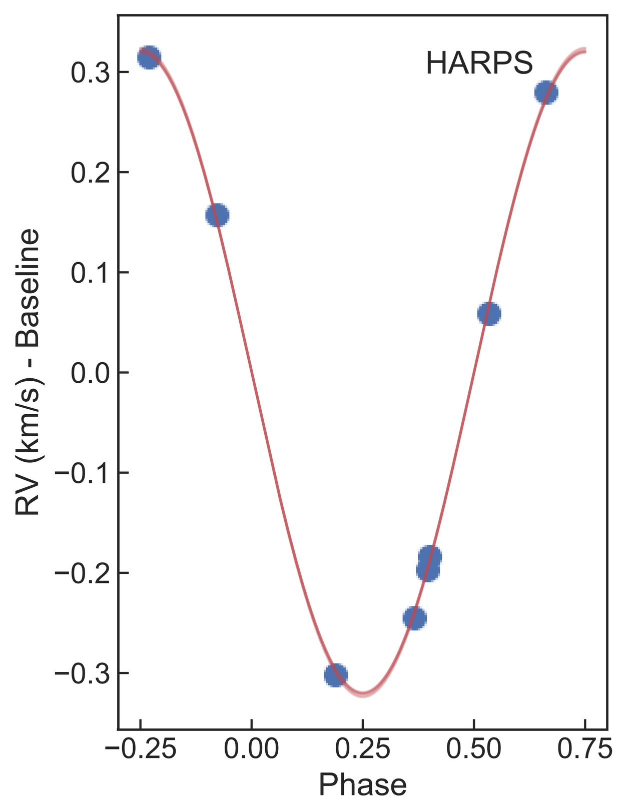

***Figure 4**: Model fit to the RV data from HARPS.*

Results and Discussion

We show that TESS data is essential when **establishing specific windows for JWST** observations in the years following its launch (Figure 5). The **decreased error for period** (Table 1) is particularly crucial, as this error compounds over time when attempting to predict transits. We are still investigating the increased error in epoch for causes such as transit timing variations (TTVs) or orbital decay. We have also begun fitting models for WASP-18 b and WASP-43 b, and will continue with the other top ESM targets.

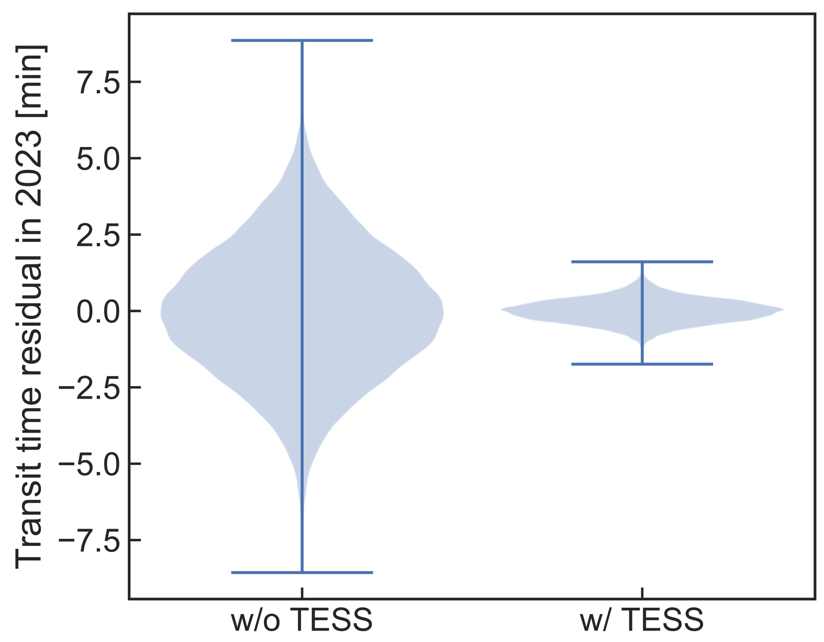

***Figure 5**: Transit timing uncertainty in 2023 without TESS (left) and with TESS (right), showing how TESS significantly decreases uncertainty.*

TESS?	Yes		No	
Parameter	Epoch	Period	Epoch	Period
Unit	BJD	days	BJD	Days
Value	2456757.2	1.3600297	2455458.4	1.3600283
Error	0.00029	2.363e-07	0.00019	5.071e-07

***Table 1**: Preliminary findings for astrophysical parameters of WASP-77A b with (left) and without (right) TESS data. Dilution from WASP-77B needs to be readjusted before final conclusions are drawn.*

Key Ideas

By using TESS data in addition to previous observations, we greatly decrease uncertainty for the period of WASP-77A b. This will be helpful when selecting observation times for atmospheric characterization with JWST. We aim to apply the same methods for other planets that are likely to have characterizable atmospheres.

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[6]Kempton et al., 2018, [7]ascl:1903.003, [8]Maxted et al., 2013, [9]Turner et al., 2016