Transit and Comparison Star Effects on Resulting Light Curves for TOI 1780.01

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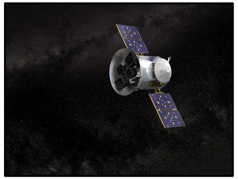
Target Selection + Methods

The target TOI 1780.01 was chosen because of its estimated > 1 % transit depth and short period, making it optimal for observation. Additionally, being a TOI, it is important to keep its transit timing parameters up to date as it will be observed again at a later date.

Regarding the methods, the analysis began using images taken by the astronomer Jay Jursich. These images were then reduced using the Exoplanet Transit Interpretation Code (EXOTIC) twice: once with a comparison star, and once without. The phase differences in minutes were calculated using Equation 1.



TESS Satellite Source: NASA

Equation 1

N = Transit Midpoint on NASA Exoplanet Archive

E = Transit Midpoint outputted by EXOTIC

p = Period of planet (Days)

n = # of full periods between Transit Midpoints

φ = Phase Difference (Minutes)

$$n = floor(\frac{E-N}{p})$$

$$\varphi = (E - N - pn) * 24 * 60$$

Abstract

Since the first exoplanet was discovered in 1995, over 4000 more have been discovered and confirmed by several different projects. The most common method of discovering these exoplanets is by the transit method, which involves plotting the relative flux of the target star against a comparison star to make a light curve. Using this light curve, one can understand certain traits about the planet by looking at the dip in brightness in the light curve corresponding to the planet coming in front of the star. One recent project released to discover candidate exoplanets is TESS. As a large number of TESS Objects of Interest (TOIs) have been released, the need for citizen scientists to frequently observe these TOIs is high. Additionally, the mid-transit time (time which the exoplanet is in the middle of its transit) changes over time, due to the uncertainty in the period of the planet, adding to the need for consistent observation. In this study, we create light curves of the exoplanet TOI 1780.01 along with updating the existing mid-transit time and studying the traits of the several comparison stars used and their effects on the resulting light curves. Additionally, we analyze the effects of larger and smaller differences in luminosity, mass, and distance between the target and comparison stars on the final light curve and we will attempt to find an upper limit on the mass of the planet based on each light curve.

Figure 1(Comparison Star Used)

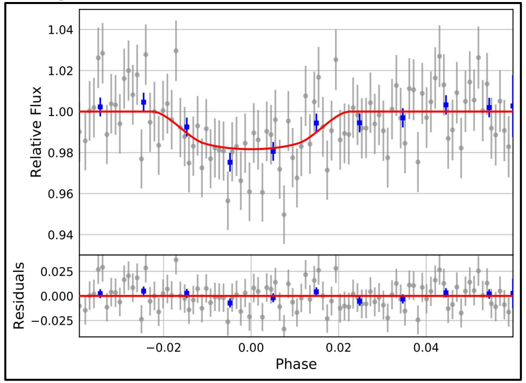
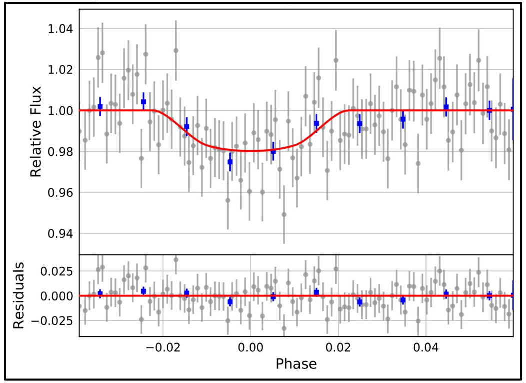


Figure 2(No Comparison Star)



Comparison Star Analysis + Results

The light curves can be seen in Figures 1 & 2. In this case, the usage of a comparison star had roughly the same scatter in the residuals (1.39% vs 1.38% for none) indicating that there was little to no atmospheric interference on the night of observation. Additionally, the comparison star used in Figure 1 was not a known variable - we can also see there are no fluctuations in the light curve.

The final results are as follows:
No comparison star & comparison star - Phase difference of **50.3 minutes** indicating that the transit midpoint on the NASA Exoplanet Archive is off.

Conclusion + Acknowledgements

From this study, we see that the transit midpoint listed on the NASA Exoplanet Archive was off by ~ 50 minutes. Additionally, the night of observation yielded negligible atmospheric effects as the light curves were nearly identical with and without the use of a comparison star

Thanks to Jay Jursich for the images and Kalée Tock for the guidance