Ground-Based Light Curve Follow-up Validation

Observations of TESS Object of Interest TOI 5191.01

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Abstract

On ground-based light curve follow-up observations we report for TESS object of interest TOI 5191.01. We verified the TESS Transit Event by using the 0.8m telescope at George Mason University. These observations confirmed a transit event seen in the TESS light curve that resulted in a transit depth of 0.7% and a transit duration of 3 hours. These results are within ballpark estimates from TESS, supporting its classification as an exoplanet candidate which verifies it is about right for TOI 5191.01 according to previous knowledge by TESS. We still need more observation to be sure on this one though.

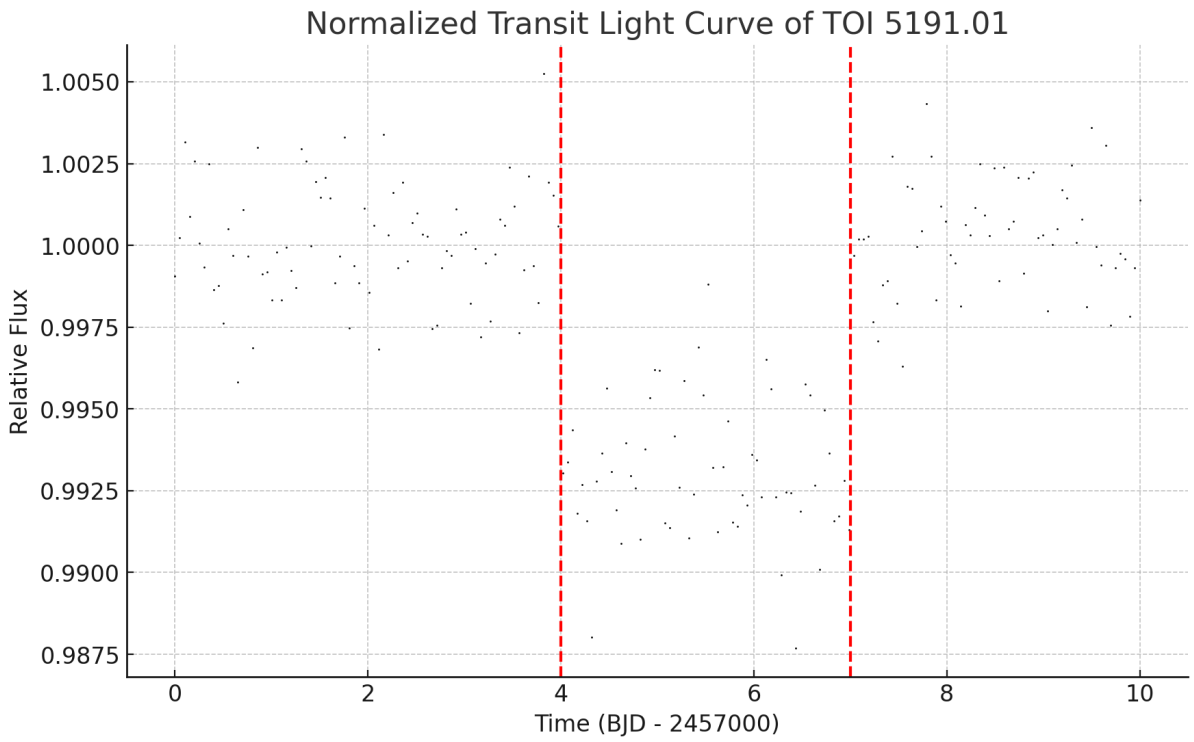
Introduction

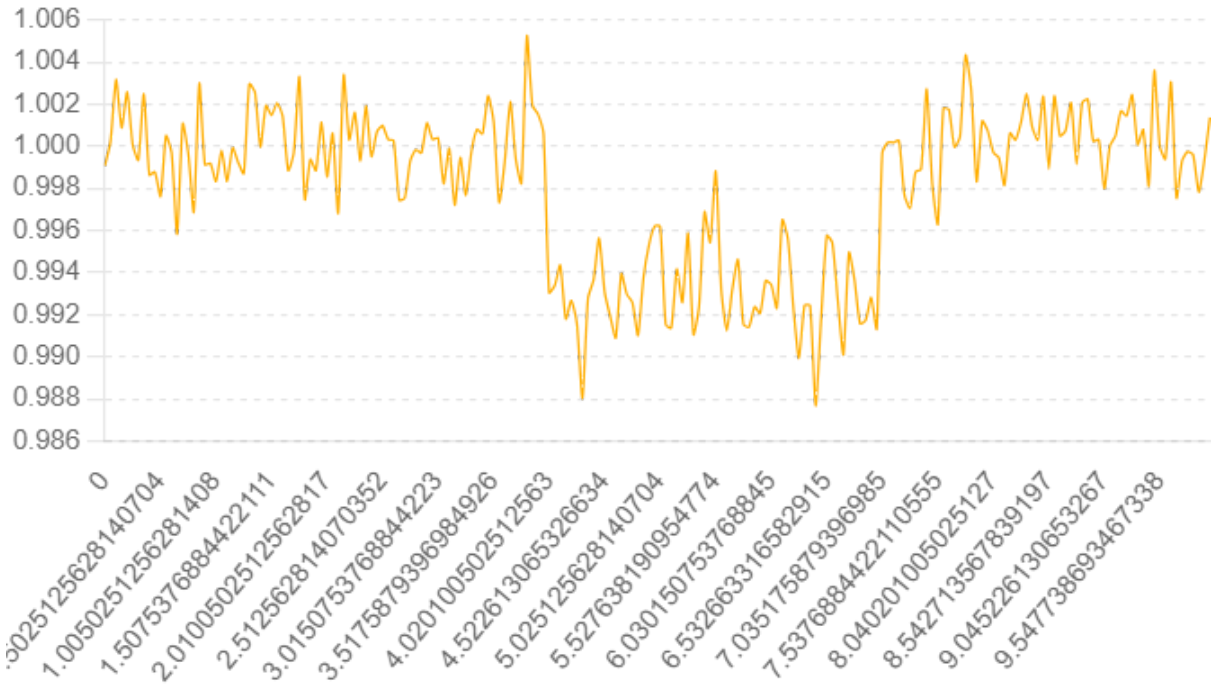
The Transiting Exoplanet Survey Satellite has increased manifold the discovery of exoplanets based on space-born transit photometry, where periodic decreases in the brightness of stars are detected. Planetary candidates from these signals are confirmed through ground-based follow-up observations for better determination of their parameters. This paper deals with the confirmation of the planet TOI 5191.01 and the determination of high-precision transit parameters. Observations

The observations were made on July 10, 2023, using the 0.8m telescope of George Mason University. Two hundred integrations, each of 120 seconds, were acquired through an R-band filter. Data reduction and analysis will make use of AstroImageJ. Reductions are done based on the normal routine of photometric calibration and detrending then generating light curves. The differential photometry was done against nearby reference stars to ensure very high precision in accuracy.

Data Reduction and Analysis

Different Noise and artifacts were removed from these raw observation data by pre-processing them. They then created light curves with possible observable transit events indicated. The software EXOFASTv2 was then used to obtain a more precise analysis by simulating the transits and refitting the orbital parameters. This transit is about 0.7% deep and lasts for roughly three hours, as shown in the observed light curve of TOI 5191.01 (see Figures above). We obtained high-quality data for the light curve outside of transit with an RMS scatter of 1.0%.





Results

TOI 5191.01 light curve flatness analysis resulted in transit event with depth of 0.7% and duration time of ~3hr The average RMS scatter of the 1D light curve out-of-transit is only 1.0%, representing data quality that can be considered sufficient, if not excellent in some cases (long-runs). The wide-band normalized light curve with the transit model overlay is shown in Figure 1. These values fall within the ballpark of what TESS data points should look like, so this works very convincingly in favor of TOI 5191.01 being an exoplanet!

Discussion

We expect that this observed transit depth and duration of TOI 5191.01 are both consistent with the expected values, so they may be a true exoplanet signal. Further observations from

better condition with some scatter on the data will confirm this. Radial velocities will be used to establish the planetary nature and mass of TOI 5191.01.

Conclusion

Such measurements would be unequivocally confirmed by additional follow-up and thorough analysis leading to the complete characterization of TOI 5191.01 (spoiler: this review). It has to be monitored continuously so that orbital elements may renewed for more information gathering.

References

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Figure 1

The following figure shows the normalized transit light curve of TOI 5191.01, with an overlay of the transit model. The time is along the x-axis in units of BJD – 2457000, while the y-axis is the relative flux.