Ground-based Light Curve Follow-up Validation Observations of TESS Object of Interest TOI-5944.01

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Abstract:

The goal of this study is to classify the exoplanet TOI 5944.01 using observation, analysis, and data synthesis of the target. In this study, I used an astronomy program called "AstroImageJ" and a guide created by Dr. Peter Plavchan in order to create a readable light curve for my target exoplanet. In this study, I found a gap in the light curve I generated from 0.81 to 0.825 Barycentric Julian Date that could be a sign of a transit. This gap falls between the predicted ingress and predicted egress times. The exoplanet I selected should be further analyzed.

Introduction:

Scientists have been studying exoplanets for decades. Exoplanets are planets that orbit stars outside of the solar system. Unlike stars, a lot of exoplanets are habitable for some organisms. Scientists want to study exoplanets because there could be signs of life on those planets. Exoplanets are also useful because scientists can compare their stellar systems to our solar system. Because of how similar some exoplanets are to the planets in our solar system, they can answer a lot of our questions about our solar system.

Though a lot of exoplanets are found every year, only a few of them are useful for scientists to study. Since there are thousands of exoplanets that have been found over the years, it takes a lot of time to analyze each and every one of them.

In this study, I observed and analyzed the exoplanet TOI 5944.01 to see if a transit occurred with it. TOI 5944.01 has a right ascension of 20:14:57.82 and a declination of +17:06:13.95. It has a period of 5.94 days and a radius of 11.945 R_Earth. The data was collected at the George Mason University Observatory on July 10, 2023 with a R filter, on a nautical twilight.

Methods:

I used a website called exofop to find data on TOI 5944.01, as well as an astronomy app called AstroImageJ to analyze and graph my target exoplanet. I used a guide created by Dr. Peter Plavchan and others to work my way through the process of analyzing and graphing my target exoplanet using AstroImageJ.

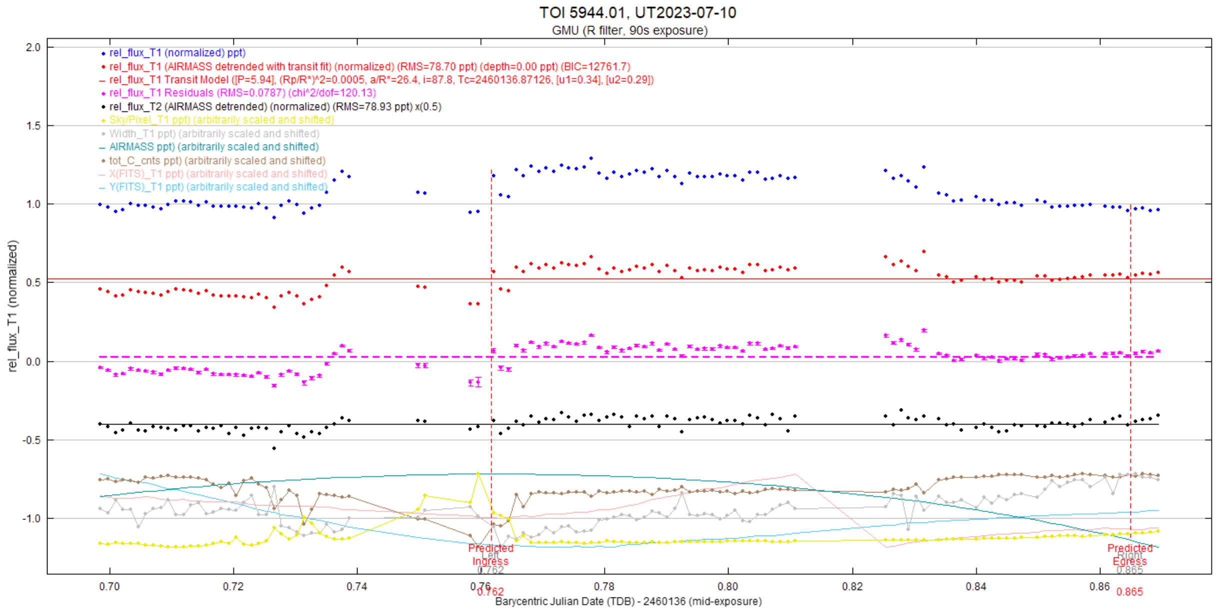
The sciences were taken with a 90 second exposure time, and the flats were taken with a 2.5 second exposure time. 10 darks were taken with a 2.5 second exposure time, 10 darks were taken with a 90 second exposure time, 10 flats were taken, 194 sciences were taken, and were later reduced to 130 plate-solved sciences.

Before plate-solving the sciences, I looked through my sequence of sciences to find and delete any sciences that had problems like the stars streaking, the stars shifting too much, or the picture being too blurry. I ended up deleting 64 of the sciences. After deleting the sciences, I changed the settings on the DP Coordinate Converter window, as well as the CCD Data Processor window before combining my flats into a master flat, my flat darks into a master dark, and my science darks into another master dark. Finally, I clicked "Start" on the CCD Data Processor window after importing my science folder and checking the "Plate Solve" box.

I then skipped to section 5.2 of the guide to generate a measurement table for a light curve. I imported the stack of plate-solved sciences and used the "Aperture Photometry Tool" button on the AstroImageJ toolbar to place a 2.5' circle around my target exoplanet. I then dragged a Gaia stars .radec file from my downloads and placed it on my first plate-solved science to get a few hundred reference stars for my target exoplanet. I placed more reference stars I selected around my target exoplanet by going to the "Multi-Aperture Measurements" window, clicking the "Place Apertures" button on the bottom, then clicking on the stars I wanted to use as reference stars. After I placed the reference stars, I right-clicked on the image to create a "Measurements" window that I could use to create a light curve plot.

Finally, I moved on to the last steps to create a readable light curve. I started by importing the measurement table I saved in the last step using the measurement table button on the AstroImageJ toolbar. After importing the measurement table, I clicked on the multiplot button on the toolbar, which created multiple windows, including the light curve graph. After spending about an hour tweaking the settings on those windows, I started working on making the light curve plot neater and more readable. In the end, although I still lacked a good understanding of AstroImageJ, I managed to create a readable light curve for TOI 5944.01.

Results:



There are gaps in the graph at around 0.74-0.75, 0.75-0.76, and 0.81-0.825 BJD. The gap from 0.81 to 0.825 BJD falls betweenthe predicted ingress and egress times.

Discussion:

There appears to be transits for TOI 5944.01. The data collected is not reliable because it was taken from Earth, and not space. I do not have a good understanding of the AstroImageJ program, so there's a decent chance I made an error somewhere in the process of generating this light curve. Furthermore, a lot of the data on the graph was shifted and scaled in an attempt to make the graph more readable. In order to classify exoplanet TOI 5944.01 properly, the science images should be analyzed again to reach a more accurate conclusion on the data.

References:

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