Light Levels for Stars Experiencing Exoplanet Transits

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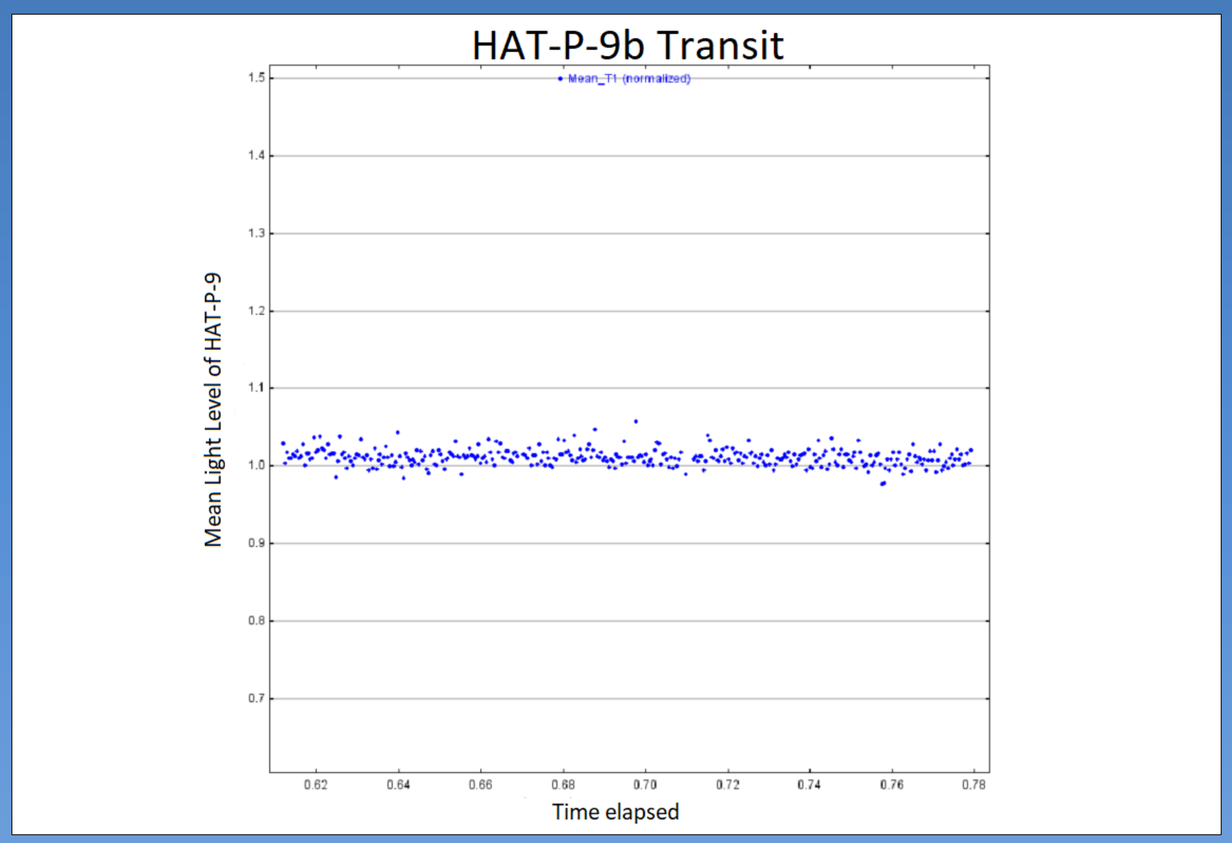
Introduction

Quite often, we do not think about how other stars that we see up in the night sky have planets of their own. These planets are called 'exoplanets'. This thought is not helped by the fact that it is practically impossible to directly observe an exoplanet. The best way for observers to currently observe an exoplanet is to either measure the gravitational wobble that an exoplanet causes on its parent star or to observe a change in light level as the exoplanet travels in between the Earth and its parent star. While faint, this change in light level can be measured by telescopes here at the university.

When the exoplanet is travelling across the star in our observing path, this process is called a 'transit'. This is how the term 'exoplanet transit' is derived. From the change in the amount of light to the length of the transit we can determine many things about the exoplanet and its parent star.

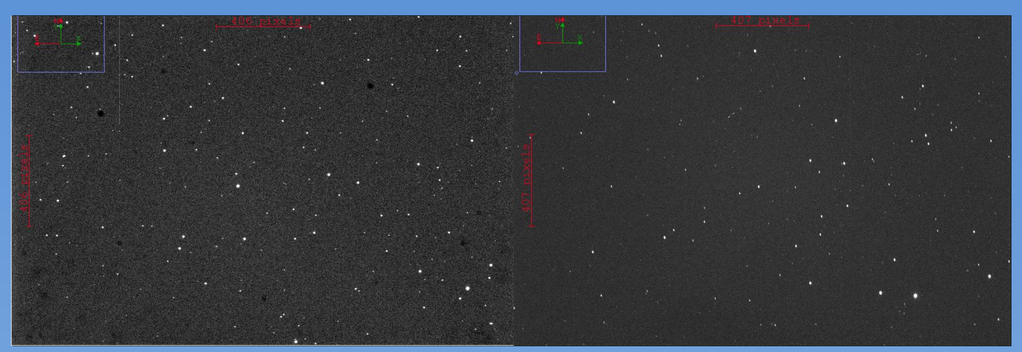
Image taken from UMD observatory website



Light level graph for the transit of HAT-P-9b on the night of Feb. 21

Method

To observe the change in light levels caused by an exoplanet transit, we used a telescope equipped with a charge-coupled device (CCD) The CCD takes advantage of the photoelectric effect. Essentially, if there is more light, more electrical charge is generated. Measuring the electrical charge, we can determine the light level of each image. With this in mind the process was quite simple. A target exoplanet transit would be determined, the telescope would be pointed at the target, and images would be taken every 30 seconds during the exoplanet transit. Images would also be taken for about ten minutes before and after the transit was complete. Software called PHD was used to keep the telescope on target.



CCD images of the night sky when observing the HAT-P-9b transit (left) and WASP-10 transit (right)

Findings

Unfortunately due to the effects of COVID-19, we were only able to complete one night of observing. However, data collection from previous years was analyzed in order to fill in for the two other nights of planned observing. As seen on the graph, there was not a noticeable drop in average light levels for the parent star (HAT-P-9)

The average level stayed consistent throughout the transit meaning that there was a possible error in data collection or an error in data analysis.

Regardless, analysis of other pieces of data proved more promising.

One of the other transit data that was analyzed was that of WASP-10, an exoplanet similar to that of HAT-P-9b. The WASP-10 transit, observed by Elizabeth Warner on August 15th, 2019 showed a drop in the average light level of the exoplanet's parent star. The drop occurred for the time of the known transit and returned to normal after the transit completed.

One of the other important things about the graph to note is that because there is a steady light level, we can deduce that there is likely no issue with the data collection equipment itself. Constant, steady light means that the lens is focuses and undamaged, as well as meaning that the CCD is undamaged and operating at a normal state.

Conclusion

One of the most important ideas learned while completing this project is that observing exoplanets thousands of light years away can be prove to be difficult – but not impossible. While analysis of the data that we collected showed a relatively steady light level, analysis of previous nights of data collection showed noticeable drops in total light level of the exoplanet's parent star.

This drop lasted for the known duration of the exoplanet transit and light levels once again returned to normal once the transit was over. With this in mind, we have once again proved that distant world can be detected with only the faintest difference in light levels from distant stars.

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