Calculating the Transit of Exoplanet HD209458b

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Abstract

HD209458b is a hot exoplanet that is considered a hot-Jupiter. In Brennan (2022) it is known that HD209458b orbits the star HD209458 in the Pegasus constellation. It is located approximately 150 light-years away from our galaxy, the Milky Way. Using data from the TRESCA database, I was able to calculate the transit for the exoplanet HD209458b. The transit data was plotted based on the emitted flux from the star and the planet passing in front. This approach allows us to identify various factors that reveal relevant information about exoplanets.

Motivation

The primary motivation for this project is to calculate the radius and the transit period for HD209458b as it passes in front of its star. Going into the project, it was known that the exoplanet was similar in size to Jupiter, with its mass being smaller and its radius being larger. This also suggests that the transit would be short.

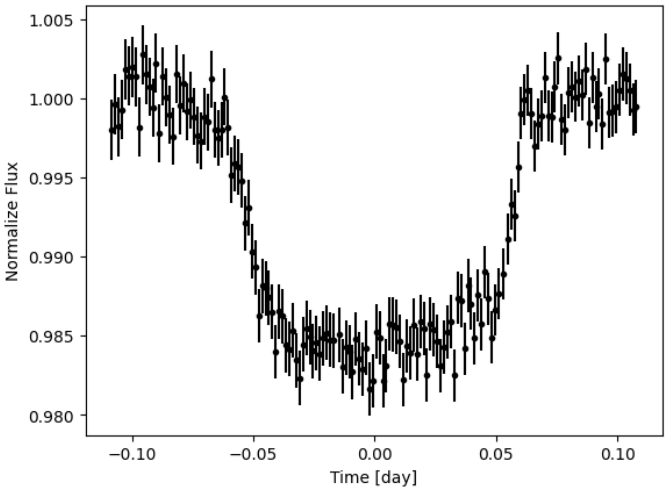
Methods

To calculate the radius and transit of the planet, the data points received from the TRESCA database were plotted. The y-axis represents the flux, while the x-axis represents time. To account for errors in the flux determination error bars were plotted as well. These errors can be caused by error in measurement or because it is difficult to determine the difference in luminosity during a transiting planet. After creating the initial plot, I also plotted a model to help visualize the transit and flux. The parameters, center time, duration, depth, and delta flux, were

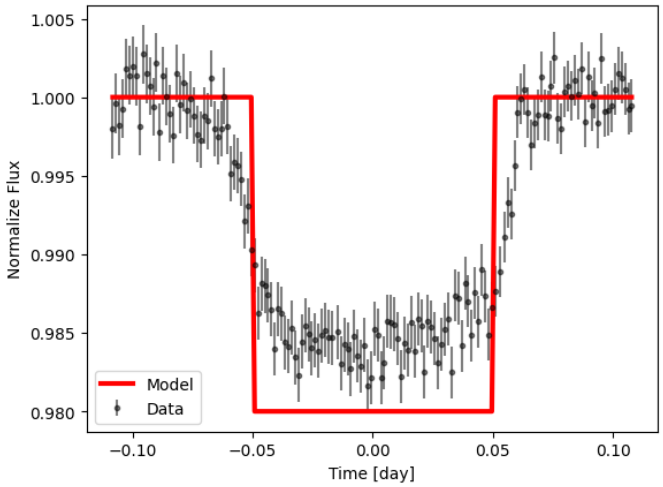
estimated to match the models to the curve in the data. The center time depicts the midpoint of the dip, duration reflects how wide the box is, depth depicts how deep the model is, and delta flux represents the slope of the lines. After inputting the values for each parameter, I used chi-squared to determine the accuracy of the model.

Results

The transit data can be seen in the graphs below. Figure 1 depicts the plotting of the original data. Figure 2 shows the box model overlapping the original data. As you can see in the figure, the box model isn't the best option for this curve. Using reduced chi-squared, we can see it yields a high value of 6.756. Using this value and the star radius I was able to determine the radius. My calculations resulted in the radius being 97,065.29 km, which is close to the radius that is stated in Brennan (2022), where their calculations were that HD209458b had a radius that was 1.39 times Jupiter's radius.



[Figure 1]



[Figure 2]

Conclusion

To conclude, the radius of the planet is 97,065.29 km, and the transit is very short, needing only 3.5 days to orbit its star. Based on how quickly the exoplanet orbits its star, its semimajor axis must also be small, considering it's only 0.04707 AU, according to Brennan (2022). Based on these calculations and the proximity of the planet, we can see that this planet would not be inhabitable, and it loses hydrogen from its atmosphere, causing a trail to be left behind in its orbital path. An interesting aspect that could be developed later would be to examine the earliest detections of the planet to now to determine how much mass has been loss due to hydrogen depletion.

References

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