Investigating the Existence of a Potential Exoplanet in the Star System V808 Aurigae

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Introduction

- 2024 research conducted by the University of Notre Dame suggested that an exoplanet was present within the star system V808 Aurigae
- Research on the system has not been published since 2024
- Main importance of exoplanet research:
  - advances our knowledge of planet formation
  - teaches us about planetary mechanics and our own solar system
  - gives us more perspective on our place in the cosmos
  - advances the search for life outside of our planet

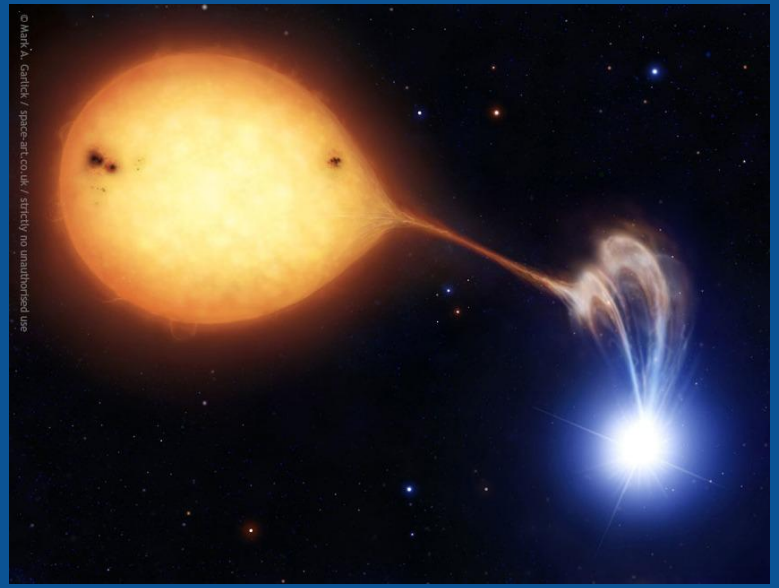
The primary goal of my research is to further explore the question of whether the V808 Aurigae star system contains a planet.

The Krizmanich Telescope, used to take photometric observations, sits atop the University of Notre Dame's Jordan Hall.

Photograph by Isaac Dubash.

Procedure - Part 1

- V808 is an eclipsing binary– it contains two stars which orbit a common center, and, as the name suggests, periodically eclipse one another
- Measurements of the system's brightness (called magnitude) show regular decreases in light output, which allow us to measure orbital periods
- After years of taking these photometric measurements, it was found that the period of the star was changing
- Research suggested that a planet with an eccentric orbit was causing these changes with the force of its gravity - a slowing rate of motion suggests the influence of another body, like a planet



An illustration of a binary star system, which, like V808 Aurigae, contains a red giant and white dwarf star.

Illustration by Dr. Mark A. Garlick, aavso.org.

Procedure - Part 2

- Measurements of the system's brightness (photometric measurements) are collected and times of eclipse are calculated
- Actual times of eclipse are compared to an ephemeris model, which predicts times of eclipse for the system assuming a constant rate. Differences between calculated and actual eclipse times are called O - C (observed-minus-calculated) values. (Ephemeris from Equation 1 of Schwope et al. 2015)
- Originally, my plan was to, with the help of a graduate student at the University of Notre Dame, use the Krizmanich telescope to collect my own measurements of the system. However, due to time / weather constraints, that was not possible, so I was supplied 2025 data of the system by Dr. Peter Garnavich of Notre Dame.
- O - C values were then compared to those found in Leichty et al. 2024

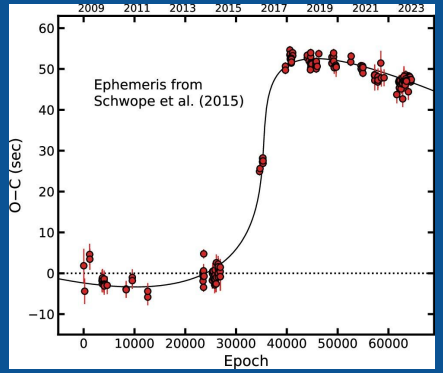
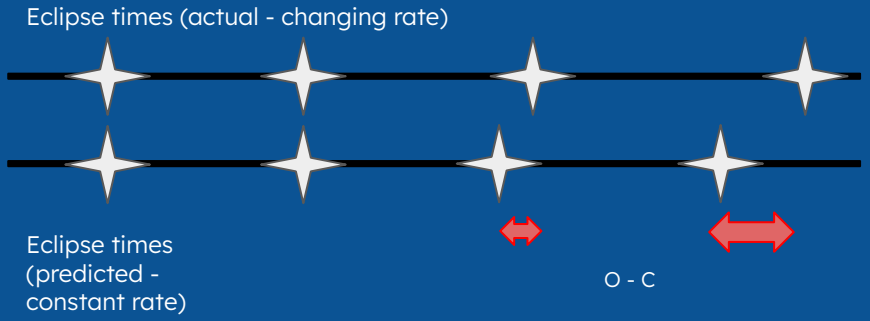


Figure 4 of Leichty et al. (2024), which analyzes 14 years' worth of data on V808 Aurigae. This graph contains a polynomial of best fit which is used for general analysis.



Hypothesis

If there is a planet affecting V808 Aurigae, then photometric measurements should follow results shown in Fig. 4 in Leichty et al. (2024), because the planet's gravity would pull on the stars, changing the time it takes for them to orbit.

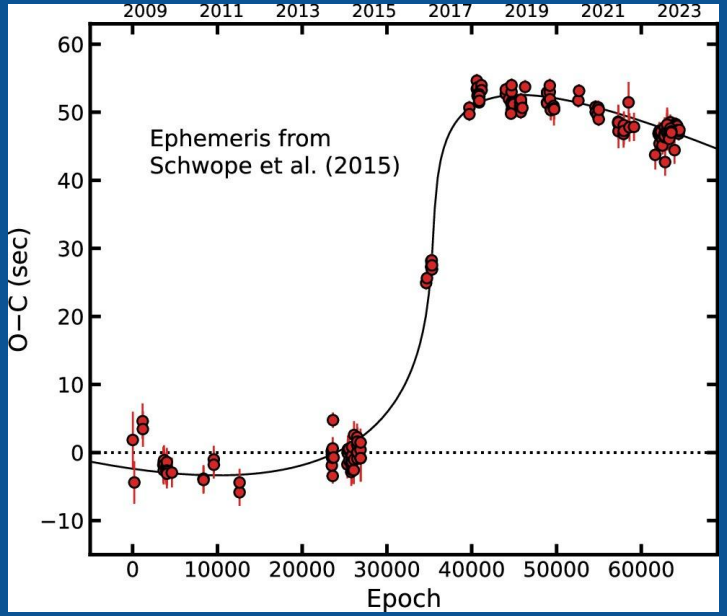
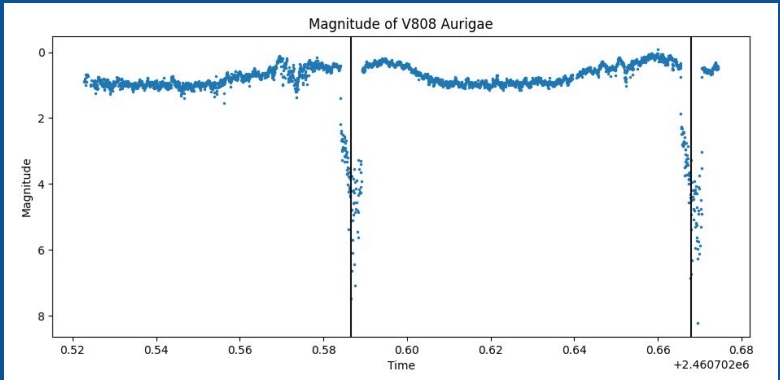
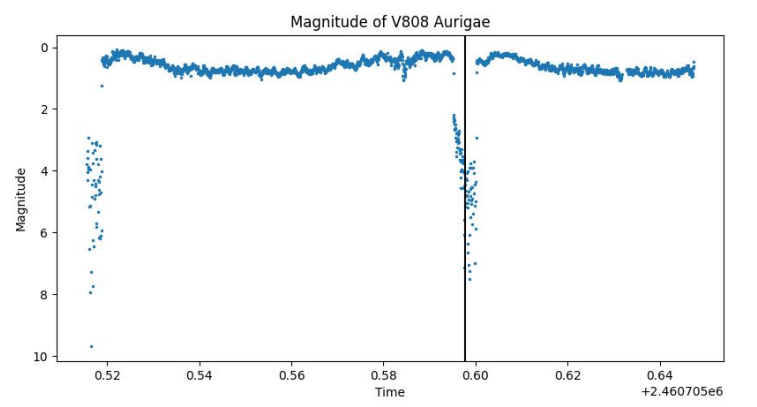


Figure 4 of Leichty et al. (2024), which analyzes 14 years' worth of data on V808 Aurigae. This graph contains a polynomial of best fit which is used for general analysis.

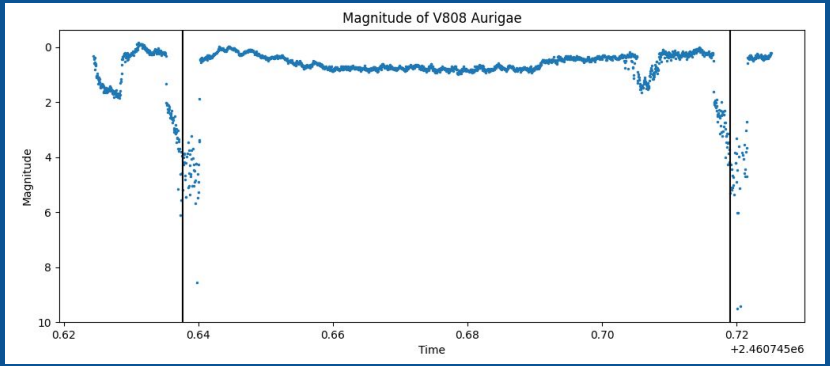
Results - Part 1



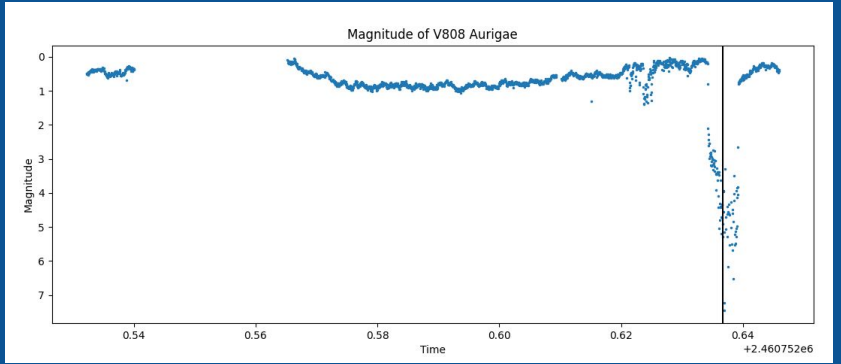
26 January 2025



29 January 2025



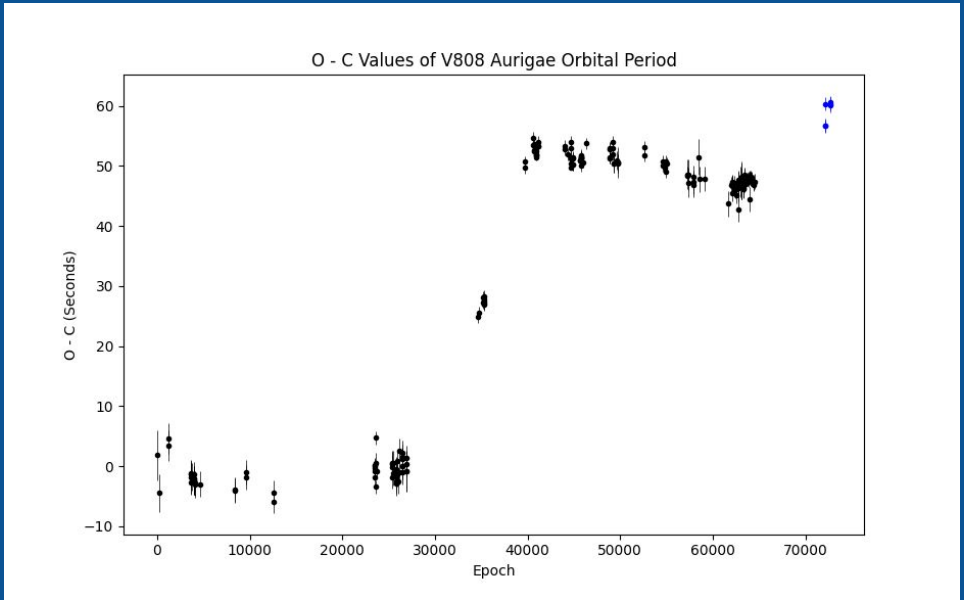
11 March 2025



17 March 2025

Photometric data collected showed 6 eclipses in total. Three of these occurred in January 2025, and three in March 2025. Vertical black lines denote eclipse times.

Results - Part 2



Data in black is from Leichty et al. (2024) and data in blue was collected by Dr. Peter Garnavich of Notre Dame. Error for data in blue was calculated by finding the root-mean-square of the scatter around the line of best fit for eclipse timings.

Graph created by Isaac Dubash.

O - C values were calculated using the ephemeris found in Schwope et al. 2015, Equation 1. O - C values have a mean of 0.0006840913556516 17 BJD (59.10549312829971 sec) , a median of 0.0006963871419429779 BJD (60.16784906387329 sec), and a standard deviation of 1.989899322203851 x 10-5 BJD (1.7192730143841273 sec).

O - C Values of V808 Aurigae Orbital Period

Eclipse	O - C Value (BJD)	O - C Value (seconds)
January 26 (1)	0.00069770822301507	60.281990468502045
January 26 (2)	0.0006555384024977684	56.63851797580719
January 29	0.0006566108204424381	56.731174886226654
March 11 (1)	0.0006950660608708858	60.05370765924454
March 11 (2)	0.000698198564350605	60.32435595989227
March 17	0.00070142606273 2935	60.60321182012558
Mean	0.000684091355651617	59.10549312829971
Median	0.0006963871419429779	60.16784906387329
Range	$4.588766023516655 \times 10^{-5}$	3.96469384431839
Standard Deviation	$1.989899322203851 \times 10^{-5}$	1.7192730143841273

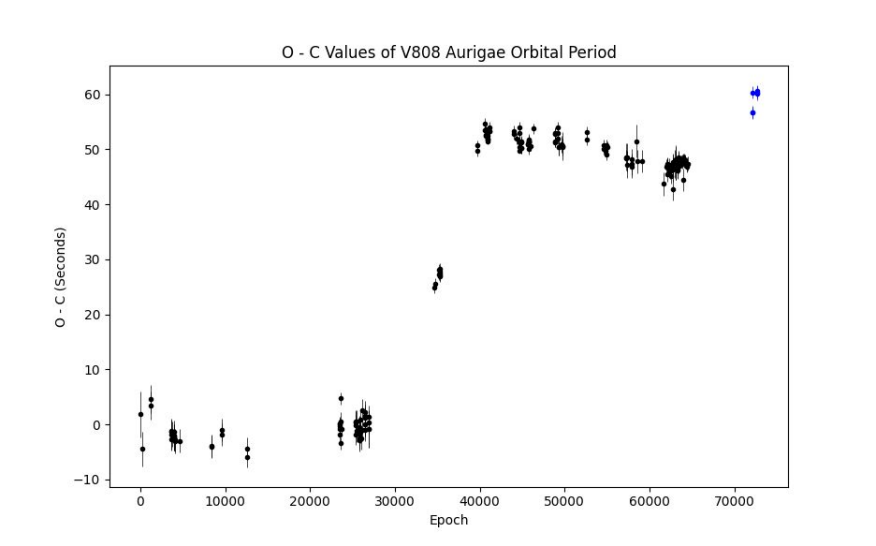
Data collected by Dr. Peter Garnavich. Calculations and table by Isaac Dubash.

Discussion & Conclusions

I would argue that my results support my hypothesis. Data in the graph shows that O - C values collected after about 35,000 epochs are between 40 and 60 seconds, which my new data is consistent with. Although a definitive claim is not possible based solely on my data, it is reasonable to conclude that the V808 Aurigae star system contains a planet.

Projects like this which study exoplanets are worthwhile because they provide significant information about the life cycles of solar systems, the potential for extraterrestrial life, and the mechanics of celestial bodies.

If I had the chance to repeat this procedure, I would have spent more time planning the collection of photometric data so that I could use more recent data and calculate error using uncertainty metrics from the telescope. These changes would give me more accurate results and more clarity in my analysis.



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