Observing Supernovae 2025rbs in NGC 7331 and eclipsing binary system V1828 Aql

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Learning objectives

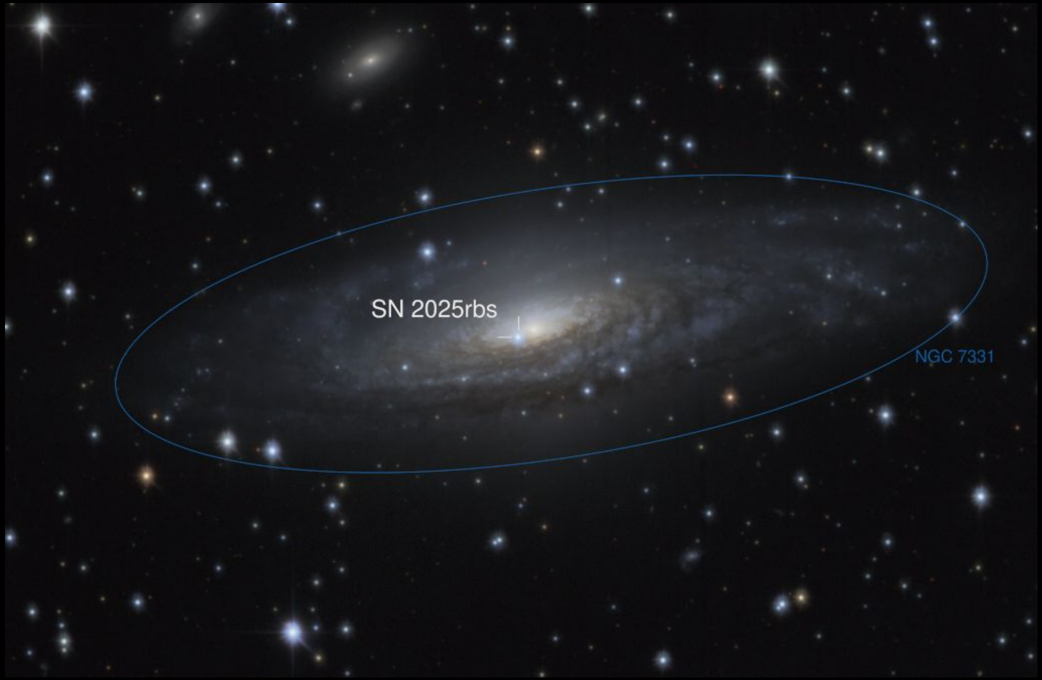
- Learn about basic components of a telescope system, and how to operate them;
- Learn how to find information of a celestial objects (visibility, magnitude ...);
- Use MaxIM DL to process image;
- Use AstroImageJ to make a light curve of those system.

CONTENT

INTRODUCTION

What is a supernova?

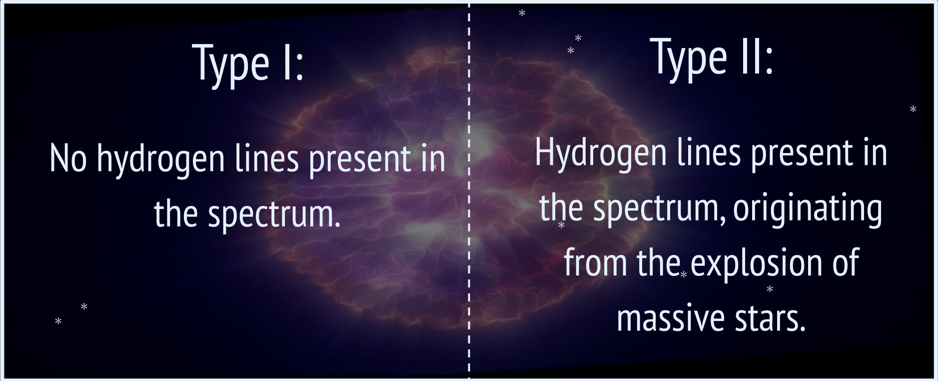
A supernova, or **supernew star**, is a powerful type of stellar explosion that creates extremely bright objects, primarily composed of plasma. They erupt violently over a short period of time. During this process, the apparent brightness of the star can increase by billions of times; it shines brighter than the entire galaxy that contains it. Afterward, its brightness gradually fades over the course of several weeks or months.



> What is a supernova?

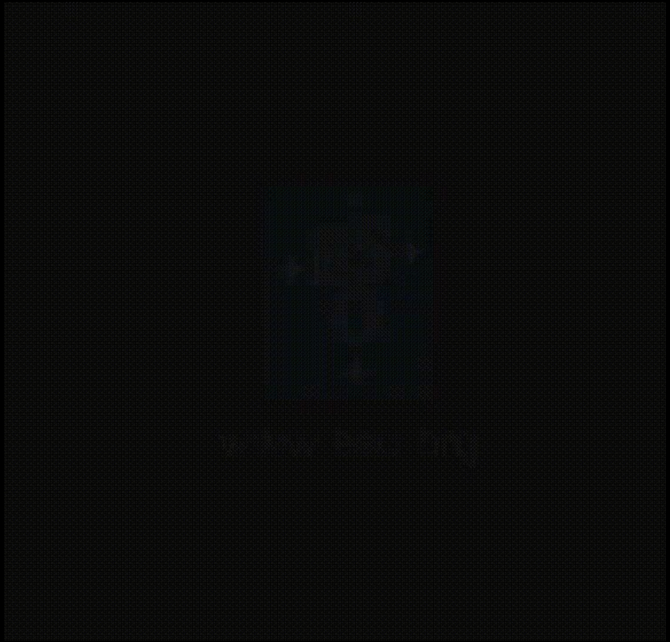
The total energy released in a supernova can reach up to **10^{44} J!**

A supernova can release energy equivalent to more than ten billion years of the Sun’s luminosity, in just up to a few minutes.



Binary star

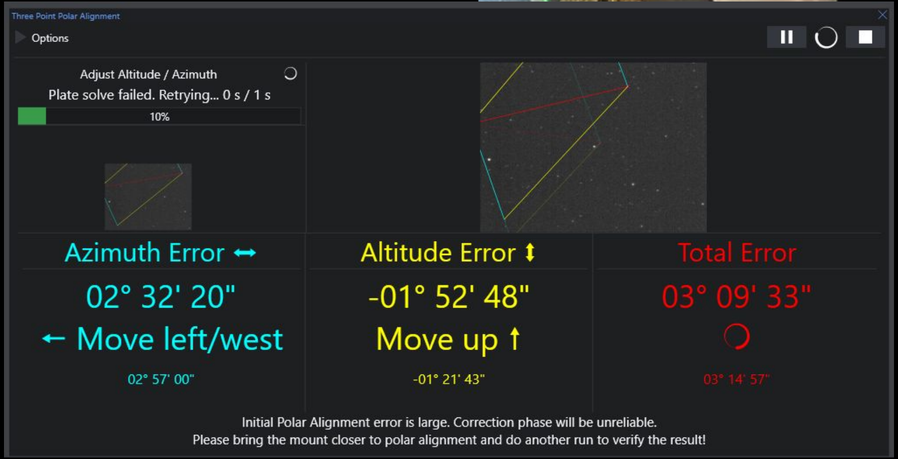
- A binary star consists of a system of two stars orbiting their common center of mass. For each star, the other serves as its companion star.
- This video shows an artist's impression of an eclipsing binary star system. As the two stars orbit each other, they pass in front of one another. Their combined brightness (seen from a distance) decreases.



Setup

- We start by pointing the RA axis of the mount approximately north;
- The Three Points Polar Alignment plugin within the N.I.N.A software is the opened used to align the mount;
- The plugin gives the coordinate azimuth and altitude errors;
- Using these we turn the mount until the total errors is smaller than 10”, completing the alignment.

Busy aligning the telescope



Setup

Finder

Finder’s camera

Filter wheel

Main camera

Laptop

28 cm telescope

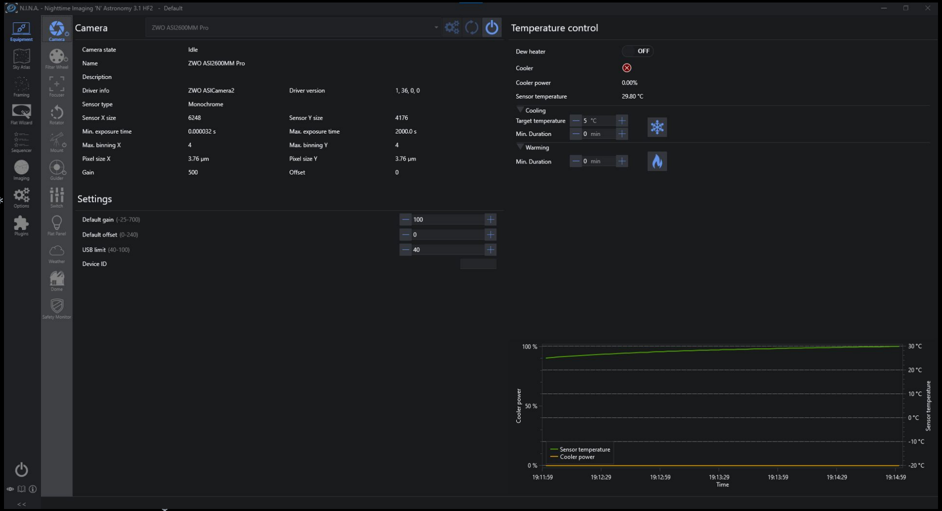
Power supply

Data acquisition

- Open Stellarium.
- Input the name of the object.
- Check the visibility of the object (is it under the horizon?).

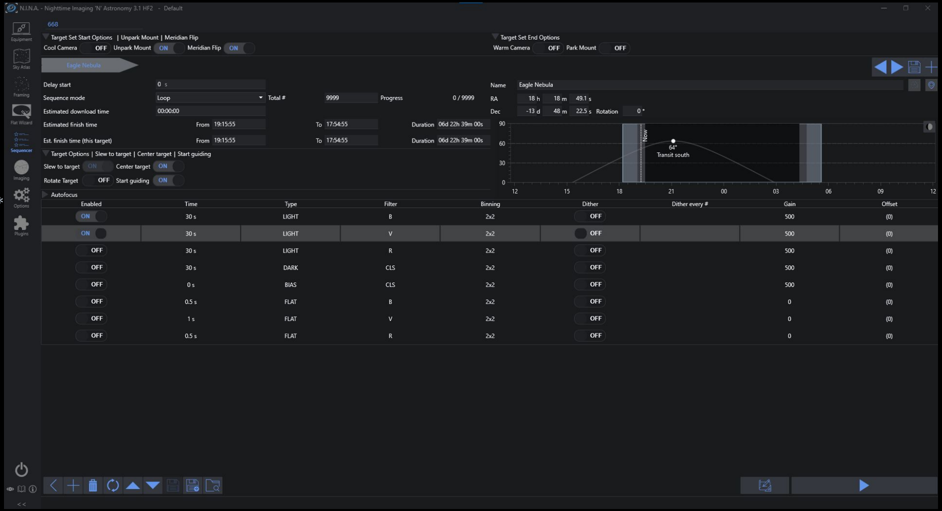
> Data acquisition

Open N.I.N.A, which controls the whole system, by connecting to the camera, mount, etc, and connect all.



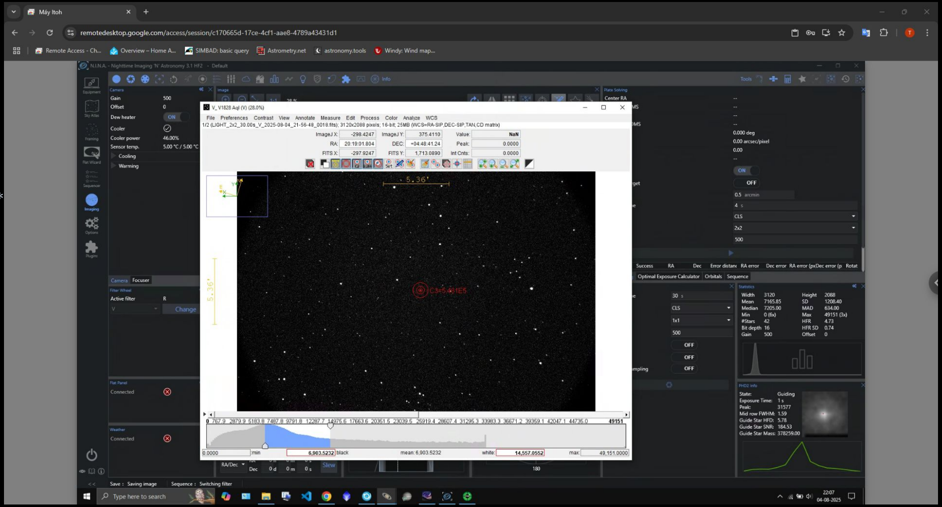
>> Data acquisition

- Open Sequencer.
- Input coordinates of the object of interest to NINA from Stellarium.
- Set exposure time, gain, filters,...



>>> Data acquisition

- Then on stable ground, with telescope aligned, begin imaging.

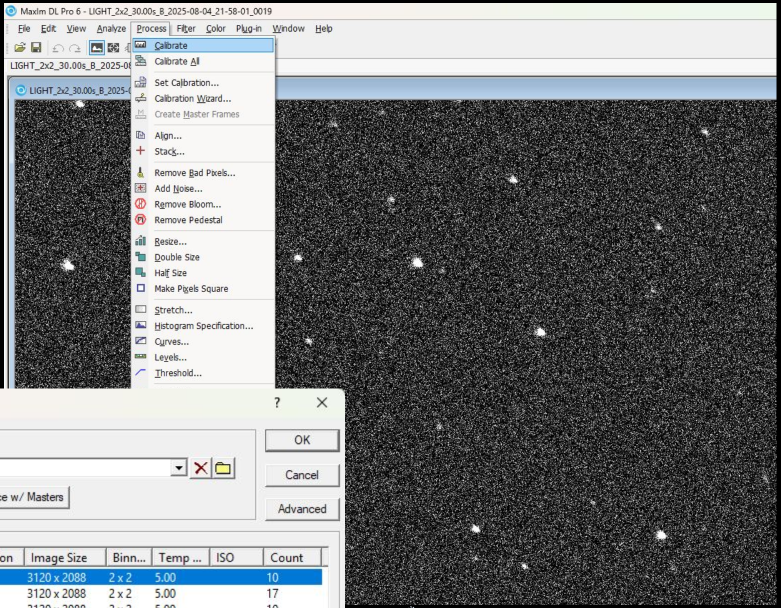


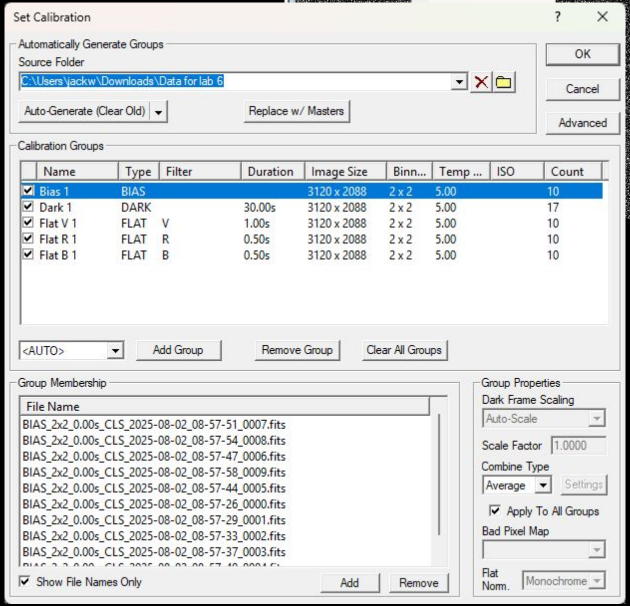
Data analysis

Image processing

We used MaxIM DL Pro 6 to calibrate our images.

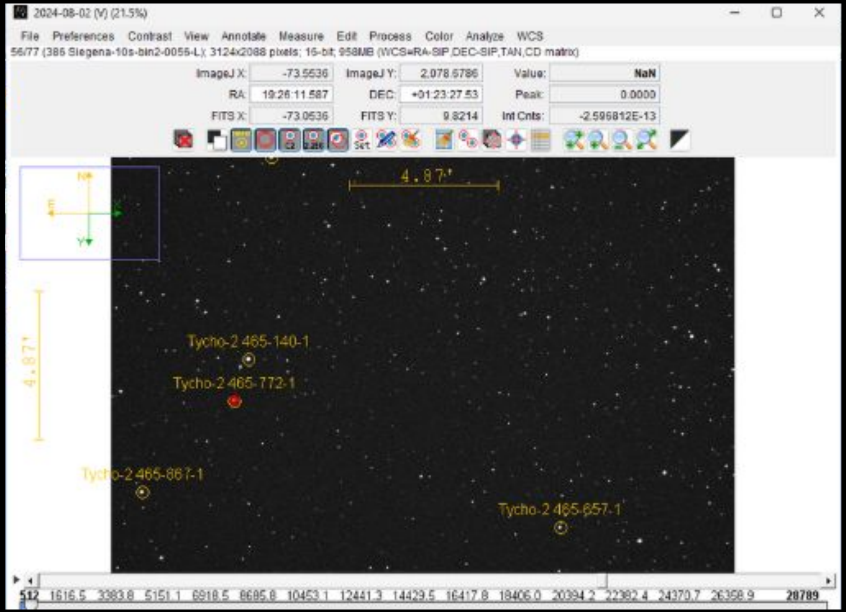
First, import all the photos (light, dark, bias, and flat) and the software will calibrate them automatically.





Measure magnitude

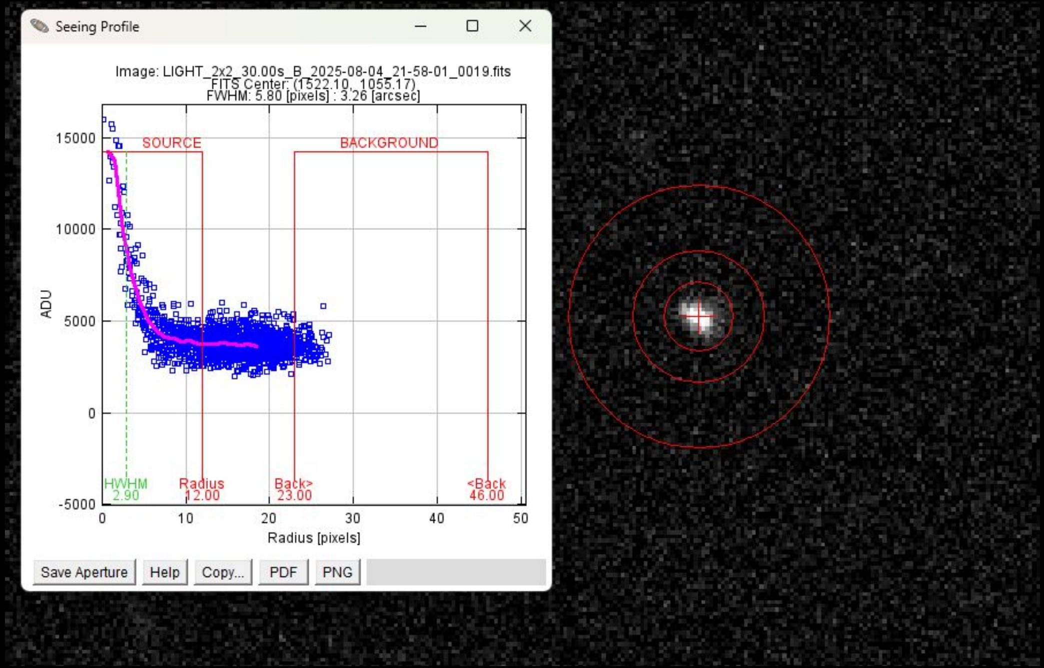
Load the calibrated images onto AstroImageJ and perform plate-solving using astrometry.net. This will identify the location of the image and which stars are visible.



Aperture Creation

To find the magnitudes of the objects in the image we use apertures, defined circular regions of space.

In order to find the optimal aperture size, we plot the seeing profile of a star in the image.



Multi-Aperture Photometry

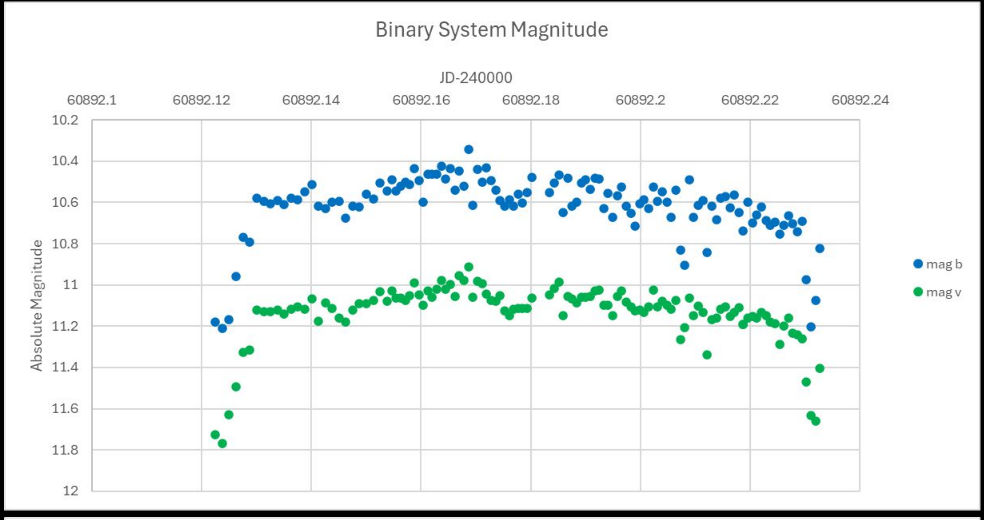
Choose "Perform multi-aperture photometry" and place the first aperture on the measured object.

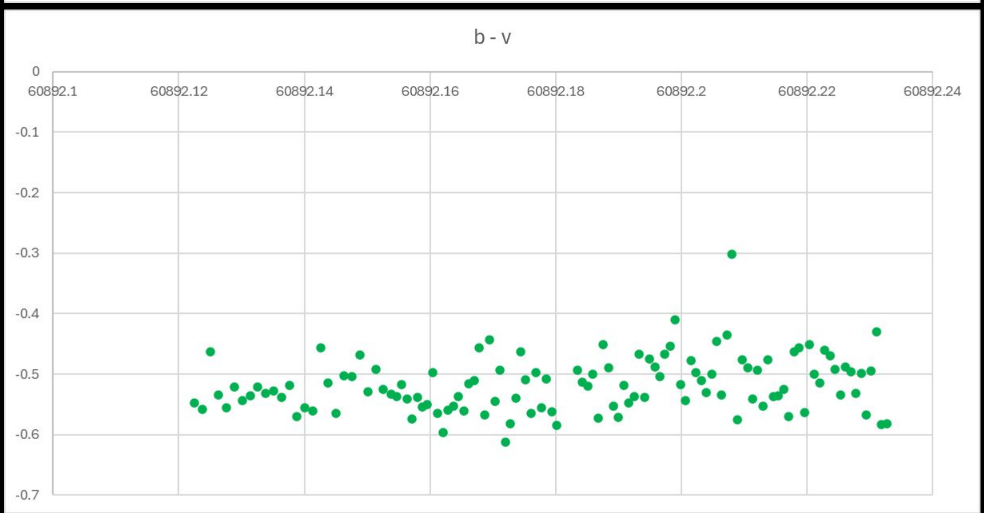
Next, place apertures on the reference stars and enter their magnitude (which can be found on https://simbad.cfa.harvard.edu/simbad/sim-fbasic).

After placing all the apertures, hit enter and AstroImageJ will create a table measuring the object's apparent magnitude throughout all the images based on the reference stars.

Results

Plotting the magnitude of the Binary Star System V1828 Aql shows a clear periodic trend as the binary stars eclipse each other, in line with its expected period of 0.11 days.





B - V light band

B Magnitude - Absolute Magnitude at 400 nm (blue light)

V Magnitude - Absolute Magnitude at 500 nm (visible/green light)

We measured the star using Ballesteros' formula as 5400 K, although the real value is closer to 30,000 K.

The calibrated images are measured in both B and V band, which then could be used to measure the temperature of a star by finding the difference between the B and V magnitudes.

Class	B−V	U−B	V−R	R−I	T_{eff} (K)
O5V	−0.33	−1.19	−0.15	−0.32	42,000
B0V	−0.30	−1.08	−0.13	−0.29	30,000
A0V	−0.02	−0.02	0.02	−0.02	9,790
F0V	0.30	0.03	0.30	0.17	7,300
G0V	0.58	0.06	0.50	0.31	5,940
K0V	0.81	0.45	0.64	0.42	5,150
M0V	1.40	1.22	1.28	0.91	3,840

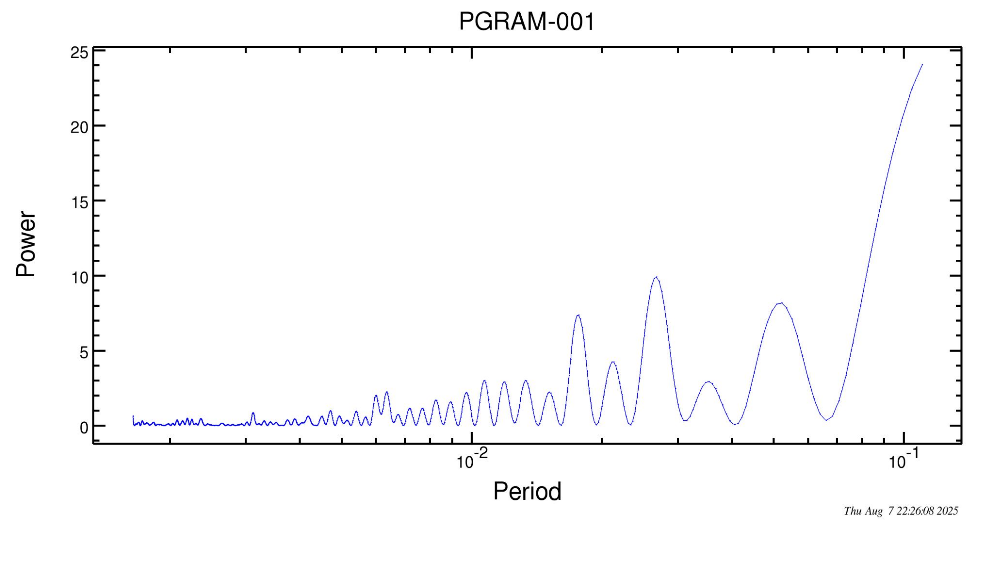
Results

Period calculation of the eclipsing binary system

Parameter Summary	
File: Aql.txt	
Points Used: 119 of 119	
Parameter	**Value**
Time Column	Time
Data Column	MagV
Algorithm	Lomb-Scargle
Minimum Period	0.00164
Maximum Period	0.11017
Period Step Method	Fixed Frequency
Fixed Step Size	0.505197
Number of Peaks	50
Peak Sig Threshold	1.0

Rank	Table of Peaks ? Period	Power	Download Curve
1	0.11017000	24.0384990	View
2			View
3	0.05213541	8.17308005	View
4	0.01767865	7.37926846	View
5	0.02129170	4.24147137	View

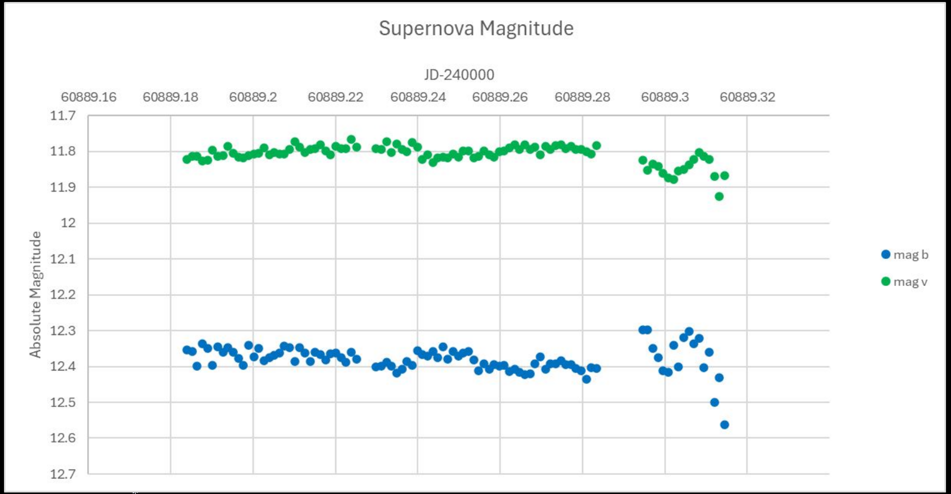
Enter Different Period for Phase Curve Rephase



Results

The supernova’s V magnitude remained fairly constant throughout our observation which is expected with supernovae normally lasting 20 - 40 days, and any changes being difficult to see across a day-long timespan.

Due to clouds towards the end of the measurement, the values grow much more variable and dim.



Conclusion

Conclusion

Through the use of our telescope system, we successfully observed a supernova and a binary star system, from which we obtained valuable data for astronomical research.

During the observation process, a key factor was the quality and light-gathering capability of the system, which enabled us to record the variations in brightness (apparent magnitude) of both objects over time.

We constructed light curves for both the supernova and the binary star system, reflecting the characteristic changes in brightness of each astronomical phenomenon.

Continued monitoring of brightness, along with comparisons with theoretical models, will be the next steps in our research.

Thank you!