Novel Nova

Light Curve Analysis of Nova AT2019tlu

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Working with Dr. Richard Plotkin and Jeremiah Paul

Introduction

Although it is easy to think of the universe as a constant, unchanging picture, the truth is that the universe and its contents are continuously changing. Nothing illustrates that more than the nova, a white dwarf that has accreted enough matter and energy to explode spectacularly. This research follows the recent nova AT2019tlu, seeking to characterize the light curve of the nova during its peak and as it fades out of the sight of the Great Basin Observatory telescope.

Methodology

Using photometry images of the target, an algorithm was created that would calculate the magnitude of the target star autonomously, only needing magnitude values from the user.

FOR each day of observations

calibratedImage ← (observation - dark frame)/flat field
ra, dec ← true center of star in pixel measurements
radius ← distance from (ra, dec) to farthest edge
blank ← number of average counts per pixel of empty sky
N_{src} ← number of counts in the star with background noise subtracted
FOR N = 8
  Find a nearby star
  User Input: What is the magnitude of this star?
  IF star has magnitude
    $m_{i,ref}$ ← user data about magnitude of this star
    $N_{i,ref}$ ← counts in the star
$m_{i,src} = -2.5\log_{10}(N_{src}/N_{i,ref}) + m_{i,ref}$
return average m_{src}

Fig. 1: Pseudocode of the algorithm used to calculate the magnitude of the target star.

Data and Observations

The data for this project was collected using the Great Basin Observatory telescope over a period of two weeks, of which one week was usable. Data was taken in the B, V, and R filters.

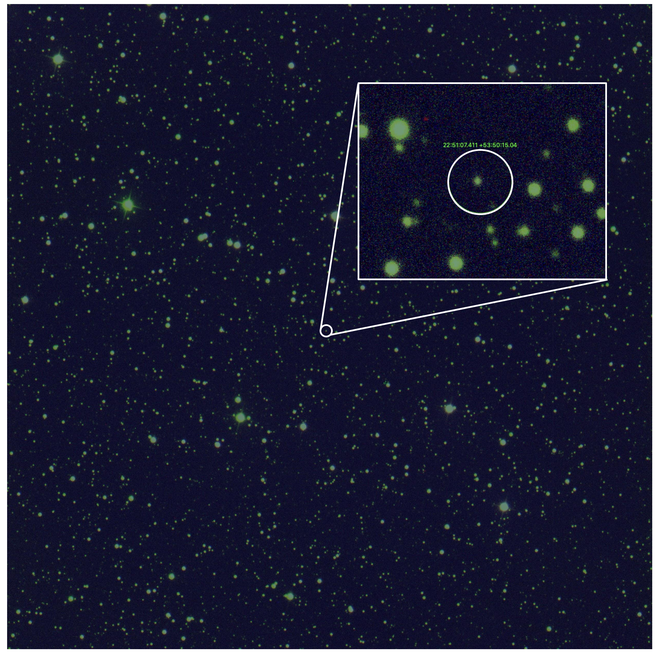

Fig. 2: Layered image of the part of the night sky containing AT2019tlu, circled in white.

References and Acknowledgements

References:

Hachisu, Izumi, and Kato, Mariko. “A Light-Curve Analysis of 32 Recent Galactic Novae: Distances and White Dwarf Masses.” *The Astrophysical Journal Supplement Series* 242, no. 2 (2019): 18. https://doi.org/10.3847/1538-4365/ab1b43.

“AT 2019tlu.” TNS. Accessed December 2, 2019. https://wis-tns.weizmann.ac.il/object/2019tlu.

Strope, Richard J., Bradley E. Schaefer, and Arne A. Henden. “Catalog Of 93 Nova Light Curves: Classification And Properties.” *The Astronomical Journal* 140, no. 1 (2010): 34–62. https://doi.org/10.1088/0004-6256/140/1/34.

Acknowledgements:

We would like to acknowledge Dr. Richard Plotkin and Jeremiah Paul for their guidance during this research project, and the Great Basin Observatory for their partnership with the University of Nevada, Reno

Results

Using the photometry data gained from GBO, the magnitudes of the star over time could be obtained and used to plot the light curve of the nova. Due to a tracking error, data from several of the days were lost, but the peak was captured, as was the end of the decline.

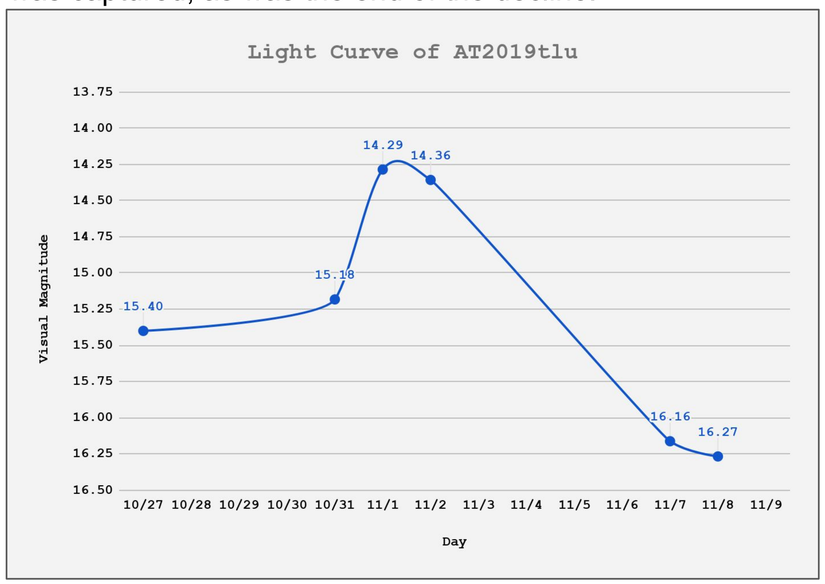

Fig. 3: This is the light curve of the nova AT2019tlu graphed over time, from right before it peaked to when it dropped out of GBO’s range.

Conclusion

The data shows that in the light curve there is a characteristic fast rise indicating the onset of the nova to its peak of 14.28, followed by the slow descent into lower magnitudes as the nova fades back to its normal magnitude at a rate of -3.672 magnitude per day. From Strope’s paper on nova classification, this nova is likely an “S” type nova, based on its smooth curve. This is the most common kind of nova, making up approximately 40% of observed nova. In order to be more certain of the classification, the nova needs to be observed for hundreds of days, not just a week.