Fainter, Fuller, Faster: Expanding Detections with TCNJ's Telescope

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Introduction

- Goal
  - Improve coadd code
  - Create photometry code
  - Observe 1 or more supernovae
- Supernovae
  - Explosive deaths of stars
  - Type Ia supernovae result from a white dwarf taking mass from a partner star

SN 2024kjb

- Type Ia supernova (Rest et al. 2018)
- Host Galaxy: IC 4566
- Distance: 15 Mpc
- Peak Magnitude: 15.32

Figure 1: Artists rendition of a type Ia supernova
Credit: NASA/CXC/M. Weiss

Results

- Improved coadd code
- Wrote a basic photometry code
- Made five observations of supernova

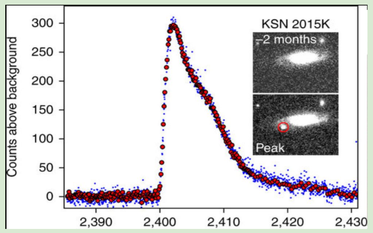

Figure 2: Typical light curve of a type Ia supernova (Rest 2018)

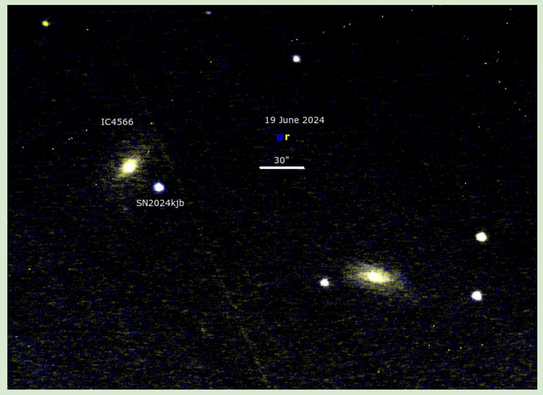

Figure 3: Images taken with TCNJ's research telescope on 19 June 2024 showing *g* in blue and *r* in yellow. IC4566 and SN2024kjb are labeled.

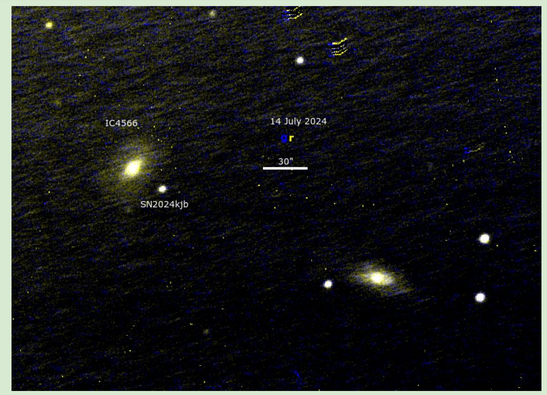

Figure 4: Similar 20-minute stacked images shown in Figure 3, but taken on 14 July 2024. Note how the supernova appears dimmer.

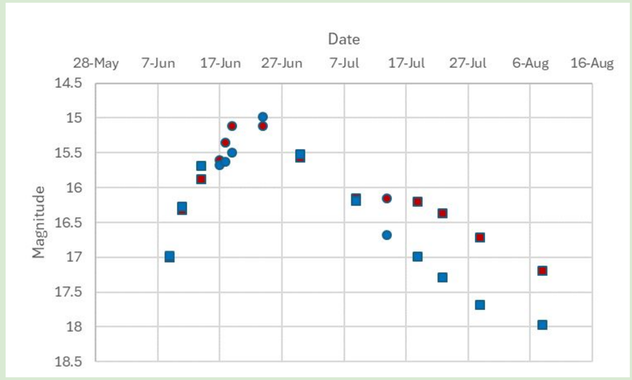

Figure 5: Light curve of SN 2024kjb. Circles are from our data, squares are from supplementary data from ZTF (Smith). Blue points are in *g* band, while red points are in *r* band.

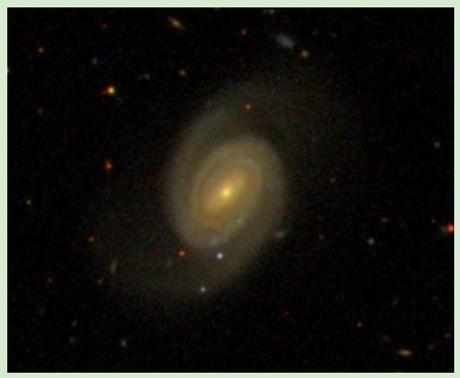

Figure 6: Image of IC 4566 from Sloan Digital Sky Survey III

Observations and Analysis

- Observations
  - Observed for 5 nights in the g and r filters
  - Each stacked exposure is twenty minutes
- AstroImageJ: Plate solving and flat subtracting
  - Flat subtraction: Correction for pixel sensitivities on the camera (Collins et al. 2017)
  - Plate solving: Adding WCS to images
- Python: Coadding and Photometry
  - Coadding: Stacking images together
  - Photometry: Determining the brightness of the supernova
- ELSA: TCNJ's high performance computing cluster
  - Used ELSA for AstroImageJ and Python

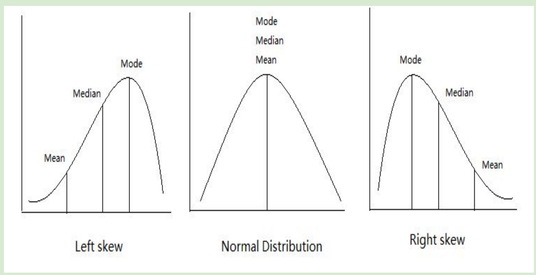

Figure 7: Visual of mean, median, and mode from medium.com, showing offset of mean and median when distributions are skewed. Median stacking would enable us to remove the effects of bright artifacts like satellites that only appear in one 60s image.

Next Steps

- Continue observing supernovae this fall using the research telescope
- Test whether we continue to detect SN2024kjb
- Undertake median rather than sum stacking (see Fig. 7 for why this might matter)
- Improve photometry code

References

Collins, K. A., Kielkopf, J. F., Stassun, K. G., Hessman, F. V. 2017, AJ, 153, 77

Rest, A., Garnavich, P. M., Khatami, D., et al. 2018, NatAs, 2, 307

Smith, K. W. et al. 2019 Res. Notes AAS 3 26