Calibrating with the RR Lyrae Star SW Dra

Logan Hicks, Stacy Brueneman, Neil Russell and Dr. Nathan De Lee

Abstract

RR Lyrae stars are variable stars that pulsate in a period of less than a day. We study them because they have a known intrinsic luminosity. With that and a measured brightness, we can get a distance, which can be used to map the galaxy. Using the NKU 11-Inch telescope and attached SBIG CCD camera, we studied SW Dra by taking images of the star over a period of time to record its brightness. We then processed the images in AstroImageJ that measured the apparent brightness of SW Dra to surrounding stars, creating a light curve. We compare this data to data from MSU's 24-inch telescope taken on the same star, and discuss the effects of instrumental setup.

NKU 11-Inch

MSU 24-Inch

Introduction

As part of commissioning a new SBIG CCD camera, we first had to ensure that is worked well with our existing 11-inch telescope and computer systems. After we got the intial setup to work, we had the question "Can we replicate the photometry we took on the MSU 24-inch on the NKU 11-inch telescope?" To be able to compare our data to the MSU data, we had to take images of a well known RR Lyrae star SW Dra. The set up is a crucial part in the experiment, considering the MSU 24-inch is mounted indoors in a secure spot, compared to our 11-inch telescope set up in the parking lot of a well-lit campus.

Materials

The materials we used are:

- Celestron 11-inch Telescope
  - Focal length: f/10
  - Field of view: 16.97 x 11.44 arcmin
  - Mounted on an ALT-AZ automated tracking tripod
  - GPS built in
  - Computer guided
- SBIG STT-3200ME CCD
  - 2184 x 1510 Pixels
  - Cooled to -10 degrees Celcius
- Filter Wheel
  - Johnson Blue, Visible and Infrared Filters used for this experiment
- Focal Reducer
  - Reduces focal length to f/6.3
  - Changes field of view to 41.64 x 28.10 arcmin

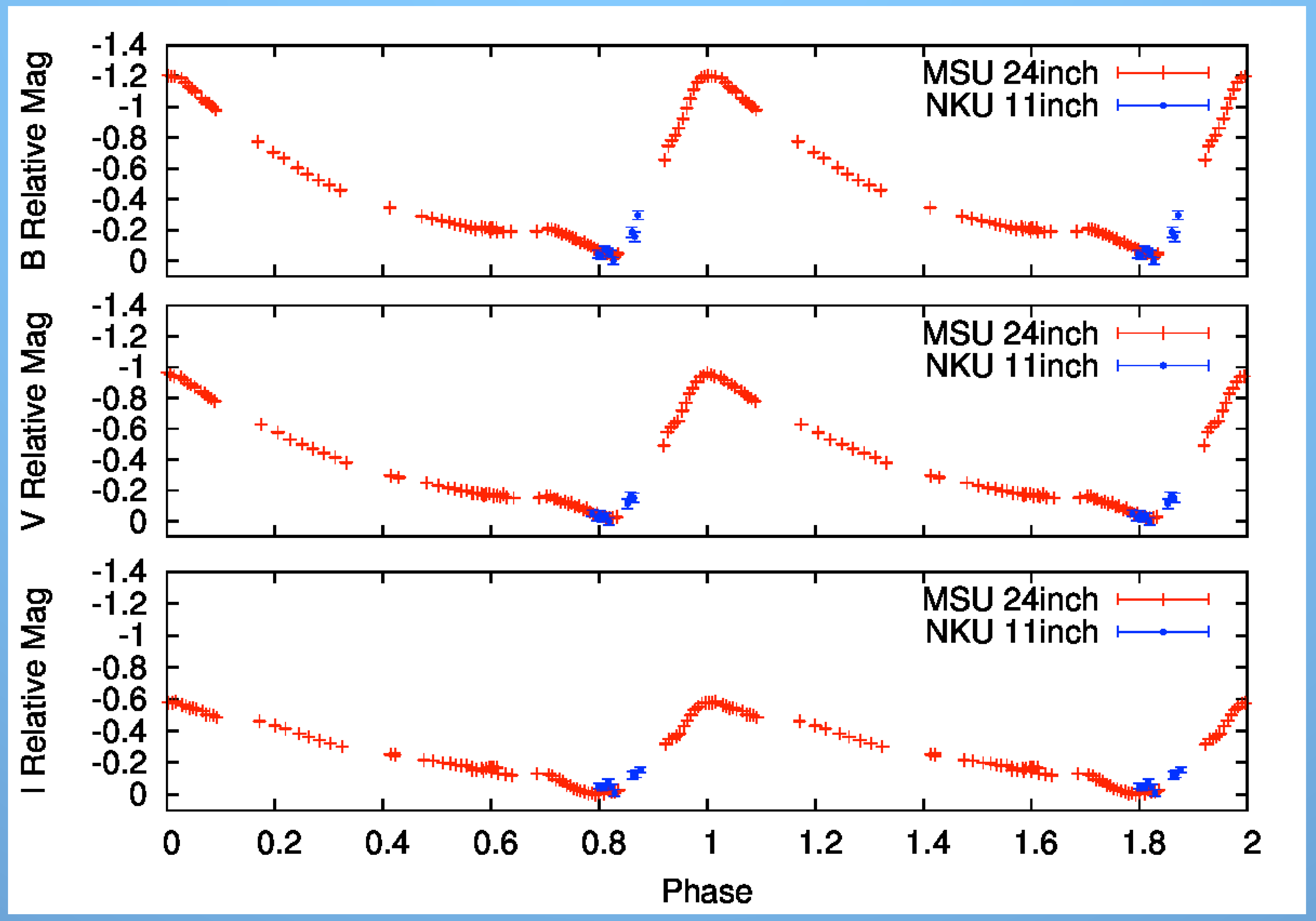
Methods

In equipment setup, you need to be as thorough and meticulous as possible. To make sure everything was set up correctly and working, we spent time hooking up the CCD to the telescope indoors and making sure the software ran correctly. Then we went out and took several photos of well known celestial objects such as M57 to make sure it was working. Once that worked, we spent an evening taking pictures of two separate RR Lyrae stars. We took them in 3 shot cycles with a Johnson Blue, Visible and Infrared filter on each image. We repeated this several times. After we were comfortable with the amount of data taken, we then used AstroImageJ to do photometry on the images in our set and the set from MSU. For further information on the process of photometry, see Stacy Brueneman's poster, "Analyzing Photometry of the Variable Star AV Peg".

Results

After doing the photometry, we received results that we could plot on a graph called a light curve. It plots the magnitude of the star compared to its phase (the remainder of date/period). The MSU data is more comprehensive than the NKU data. The idea is to see how well the NKU data falls onto the MSU data. The resulting graphs are below.

Multi-Filter Phase Vs. Magnitude



The blue points are the data we took and plotted along the MSU data, which are the red points. By comparing the NKU magnitudes to the MSU values by using a smoothed spline interpolation (Pollock 1999), we found that we achieved 2% error in V and I, and 3% error in B. We also found that our average period was 0.569608 days compared to 0.569670 days from the General Catalog of Variable Stars (Samus et al. 2009).

Discussion

The results, although satisfactory, are not the 1% photometry that we would like to achieve. There are several factors in why our results may have been slightly askew. One factor, we believe, is the focal reducer. This caused the field of view to be much larger than the MSU telescope's field of view, as shown below. This is useful if the telescope pointing is imprecise. However, this also causes that the light from a star to be concentrated in a few pixels,

NKU 11-Inch MSU 24-Inch

SW Dra is circled in red

which means that we could not expose our images as long without saturating our bright comparison star ultimately limiting our signal to noise. Also, the focal reducer, produces an unequal distribution of light that can be removed with a Flat field (an image of a blank sky), but they are difficult to obtain at high signal to noise. If our Flat images do not have enough signal to noise, this could reduce the quality of our photometry. The focal reducer also caused the focus to change as a function of filter, which could affect the photometry as well. Given all this, we try not using the focal reducer in future imaging.

References

Pollock, D. S. G. 1999 A Handbook of TimeSeries Analysis, Signal Processing and Dynamics, (Cambridge: The University Press)

Samus, N.N., Durlevich,, VizieR Online Data Catalog, 1O.V., & et al. 2009

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