Analyzing Photometry of the Variable Star AV Peg

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ABSTRACT

RR Lyrae stars are distinct from most stars because they pulsate with a particular period from hours to one day. RR Lyrae are used as “standard candles” due to their known average intrinsic luminosity, which when combined with their measured brightness, gives a distance. We set out to observe an RR Lyrae star, AV Peg, using the NKU Observatory 11-inch telescope. This was achieved by attaching an SBIG CCD camera to the telescope and taking images over a period of time. We used AstroImageJ to measure the brightness of AV Peg and several comparison stars to plot brightness variation over time. This was then compared to data taken from the Michigan State 24-inch telescope showing we can achieve similar results.

AstroImageJ

Fig. 1
(Target Star in green; Comparison Stars in red)

INTRODUCTION

The discovery and understanding of RR Lyrae variable stars is important to the world of astronomy because they are useful in measuring relative distances in the universe. But how does an astronomer go about finding that distance? Astronomers, such as ourselves, use a special camera called a CCD (charged-coupled device) that we attach to the end of a telescope. This device is considered a “photometer” because it receives photons from celestial objects and processes them into electrical signals that can be used to produce a picture which represents that star’s apparent brightness. Astronomers then process the photos through a technique called “photometry.”

Light Curves in Phase vs. Magnitude

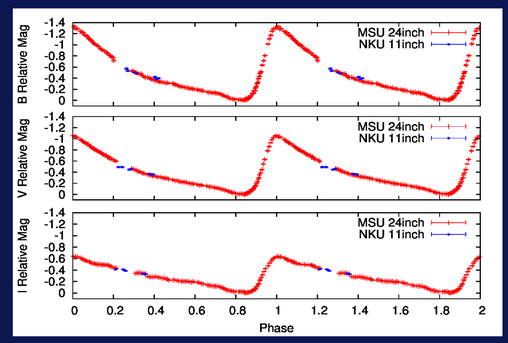

Fig. 2
(Light curves of AV Peg in the Johnson Blue, Visible, and Infrared filter)

MATERIALS & METHODS

The telescope and camera setup are described in Logan Hicks’ poster “Calibrating with the RR Lyrae Star SW Dra.” To implement the photometry, a program called AstroImageJ (AIJ) was used. First, the series of images must be aligned so that each star lies in the same position on each frame. This is done by identifying a pattern of stars on each frame and then matching the pattern on each frame. Then it is time to place the sky annulus and star apertures that measure the “flux”, or amount of photons, in the region. The aperture focuses on the photons directly from the star, using its center of light (a similar calculation as a center of mass). The annulus simply measures the flux from the sky to account for the sky background, which is later subtracted from the light in the star aperture. Finally, the “target” star and several comparison stars are selected to observe the change in brightness, as seen in Figure 1. AIJ calculated the flux of the target star by taking the “counts,” or number of photons, from the target star and dividing it by the counts of all the comparison stars. Once AIJ processed all the images, it produced a plot showing the relative brightness of each star over the period of time taken place throughout the images.

RESULTS

We used Supersmoother (Reimann 1994), period finding algorithm, that allowed us to phase (the remainder of date/period) the two light curves. We then compared the magnitudes of the two curves by interpolating the MSU data using a smoothed spline (Pollock 1999) and finding the standard deviation of the NKU points as shown in Figure 3.

DISCUSSION

As seen in Figure 2, our data, which is represented by the blue points, falls almost directly on the Michigan State data, represented by the red points. After using interpolation, shown in Figure 3, we found that in the Blue and Visible filters we had about 4% error, where in the Infrared filter, we had about 1% error. Our findings are highly motivating because it tells us that we can produce relatively accurate photometry using the NKU 11-inch. With more data we could improve our period finding to better match the period given by the General Catalog of Variable Stars (GCVS) (Samus et al. 2009). Our average period was 0.39072 days compared to GCVS 0.39037 days.

Spline in Phase vs. Magnitude

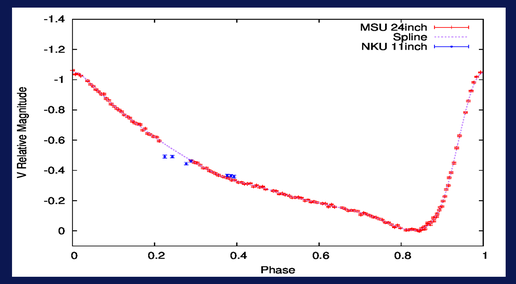

Fig. 3
(Spline overlaying light curves of AV Peg in the Visible filter)

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