Observation of RR Lyrae Variable RS Boo

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Introduction and Background

The idea of this observation project is to get a good idea as to how a variable star can be observed to the point that it is possible to determine the magnitude and period of fluctuations in brightness. A variable star is, as stated above, a star that fluctuates in brightness with regularity. In this case, the star being observed is RS Boo of the constellation Boötes which is a RR Lyrae variable. A RR Lyrae variable is one that that is named after the reference variable RR Lyrae of the constellation Lyra[1]. This particular variable is a RRAB type, which is a RR Lyrae with an asymmetrical light curve with a period between 0.3-1.2 days and an amplitude of 0.5-2.0 magnitude in V. RS Boo is a known variable with a magnitude range of 9.69-10.84V and a period of 0.37734 days[2].

Equipment

- 6” Astro-Physics Inc. Refractor Telescope
  - 6” Aperture
  - 54” Focal Length
- SBIG ST10-XME CCD Camera[3]
  - Resolution: 2184 x 1472 pixels
  - CCD Size: 14.9 x 10 mm
  - 3.2 Megapixels
  - Pixel Size: 6.8 Square microns
  - Exposure Range: 0.12 – 3600s
- Astrodon Photometric Sloan Gen 2 r’ Filter[4]
  - Wavelength Range: 562 – 695 nm

Software

- MaxImDL – Imaging Software
- AstroImageJ – Photometry Software
  - Provided by The University of Louisville

CCD Imaging[5]

A CCD (charge-coupled device) is a sensor that consists of an array of light sensitive elements that collect electrons in capacitors which then is translated into numbers and displayed as an image. Depending on the analog-to-digital converter, there is a range of gray shades that comprise the image taken. For example, an 8-bit image contains 2^8 shades of gray.

Due to the nature of how the CCD works, absorbing light generates heat which creates “thermal noise”, and thus the sensor needs to be cooled. Figure 1 shows how a CCD works.

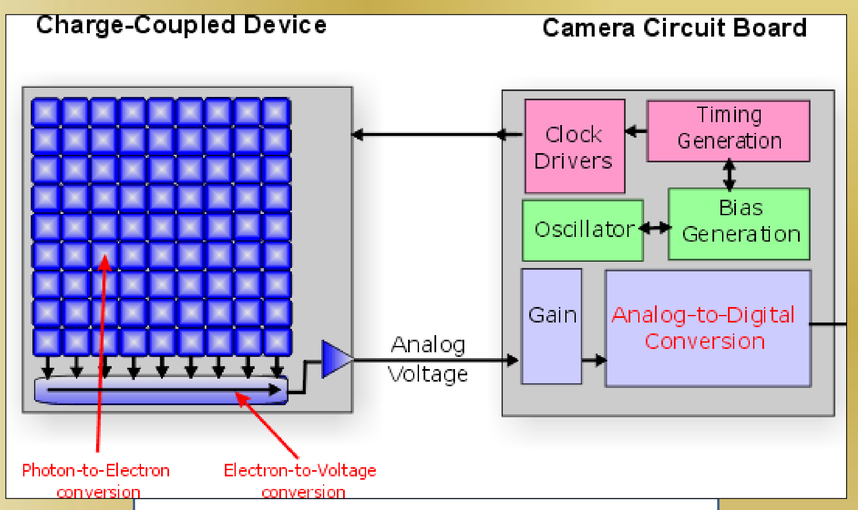

Figure 1: Simple visual aid to explain how a CCD works. The light hits the “checkerboard” on the left and the electrons are stored in the capacitors on the bottom. Then the analog-to-digital converter produces and image from the data obtained.[6]

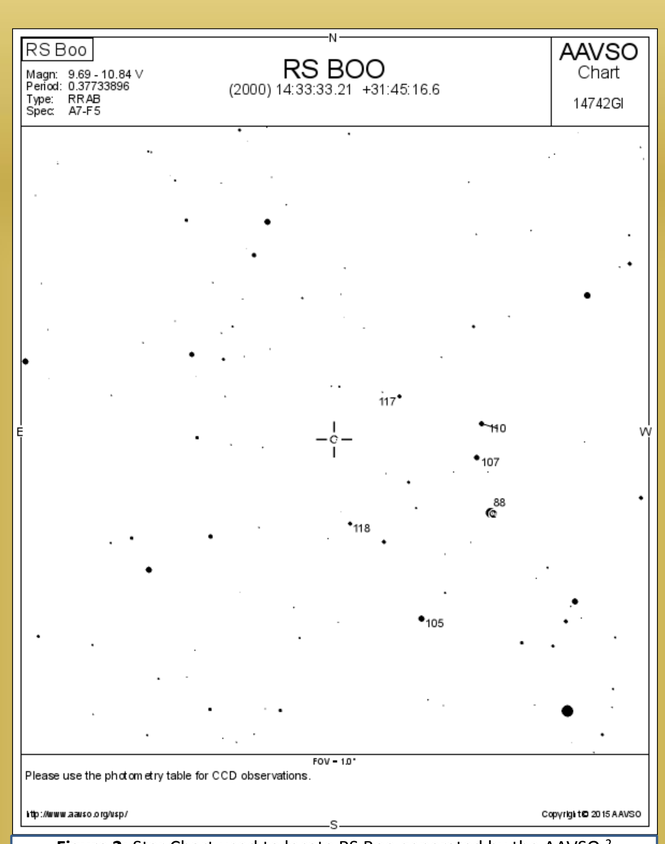

Figure 2: Star Chart used to locate RS Boo generated by the AAVSO.[2] Note objects 110, 107, and 88 for Figure 3 below.

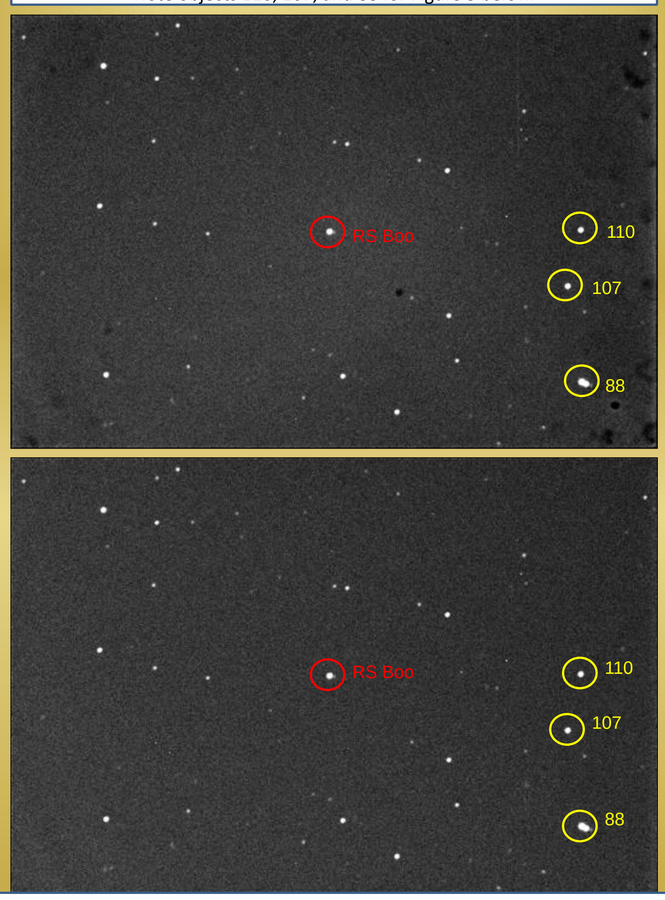

Figure 3: (Above) Raw Image of RS Boo. (Below) Calibrated Image of RS Boo. Objects 110, 107, and 88 from Figure 2 are labeled. The calibration process eliminates the spots seen throughout the raw image. The spots are due to dust on lens and/or filter

Procedure

1. Begin cooling the CCD camera(s) about 4 hours prior to imaging.
2. Shortly before dusk, take a series of flat images for later image calibration.
3. Shortly after dusk, sync to a known, visible star (Algieba in my case).
4. Using right ascension and declination, find the star to be observed.
5. Upon finding the star and centering in-frame, take some sample images to determine optimal exposure time.
6. Take a large series of images at the optimal exposure. The number of images should be large, but is arbitrary.
7. At the end of the evening, take another series of calibration images.
8. Use AstroImageJ to analyze images and generate a light curve.

Results and Future Work

- While some data was obtained, the weather hampered attempts to obtain data for conclusive results.
- Even though sufficient data was not obtained, the experience of using the telescopes and imaging/processing software is invaluable.
- This research is ongoing. Once RS Boo is successfully analyzed, efforts will be turned to a lesser-known variable star.

Figure 4: Image of the 6” Astro-Physics Refractor Telescope synced to Venus, with the waxing crescent moon nearby.

References

1. http://en.wikipedia.org/wiki/RR_Lyrae_variable
2. http://www.aavso.org/vsx/index.php?view=detail.top&oid=4314 – AAVSO Database entry for RS Boo.
3. http://archive.sbig.com/sbwhtmls/st10.htm - SBIG ST10-XME camera information page.
4. http://www.astrodon.com/sloan.html - Photometric Sloan filter information page.
5. http://www.astro.umd.edu/openhouse/2programs/ltsn/handouts/u59.pdf - Document by Elizabeth Warner detailing CCDs.
6. http://www.jiscdigitalmedia.ac.uk/images/ccd_fill_factor_big.gif - CCD visual aid.

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