Commissioning the Robbins for Undergraduate Research

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• Location: Central Oregon (30 min East of Bend)
• Great viewing due to:
  • Dry climate
  • Cold nights
  • Altitude: 6300 Ft
Pine Mountain Telescopes

14 inch (Robbins)

15 inch (JW Fecker)

24 inch
Public Nights

• Open to the public Fridays and Saturdays, memorial day weekend through the first weekend of September (weather permitting)

• The 24-inch, 15-inch, and usually 10-inch telescopes are available for the public viewing with volunteers’ help
The Robbins

- Robbins Dome 2014
- CCD Camera: Apogee Alta F9000
- 35x35 arc minute field of view
- 0.7 arc second per pixel
- German Equatorial Mount
- Plan to have remote operations from University of Oregon campus
- Main research telescope at PMO
System Commissioning

Learned to use System Programs:
- Maxim DL: operation of telescope
- APCC: connection to telescope mount

Made the operational procedure:
- Troubleshooting
  - Power outages, system loosing connection to the telescope

Made the observing log:
- Data on clear skies, temperature, and exposure time used for stacking images
- Tells collaborators the conditions in which their data was taken

Learned to operate Robotic Telescope
Site Characterization

We used clear skies chart to determine atmospheric conditions at Pine Mountain; specifically, the seeing category.

With more data, we will be able to match clear skies’ seeing scale (0 to 5, with 5 being the best), to the Robbins seeing abilities (in arc seconds).
Charge Couple Device (CCD)

- The Robbins uses an Apogee Alta F9000 CCD camera
- Light hits and energizes the silicon chip in the detector, so an electron is emitted (photoelectric effect)
- The electrons are gathered in pixels until the exposure is over
- After the exposure, the CCD reads the chip column by column
- Once the entire chip is read out, the signal is amplified, then is converted from analog (number of electrons) to a digital picture

http://www.digicamhistory.com/Janesick_CCD_Readout.jpg
Biases

• The bias measures the noise in the data from the physical process of reading the chip through:
  • Amplifier
  • analog to digital converter

• Measured by taking a zero second exposure without exposing the CCD to any light
Darks

Dark Current:
- Thermal agitation sometimes make the electrons in the CCD excite without exposure and collect in the pixel wells
- This means that the electronic noise changes depends on the temperature and exposure time
- Take a picture with the shutter closed for the same amount of time as data, called a dark frame
- Subtract the biases from the dark frame to produce a thermal frame, a measure of the dark current

![Graph: Temperature vs Dark Current](image)
Flat Fields

- Dust and debris can build up on the optics of the telescope, adding a layer of noise to the data.
- A flat field is an exposure of a uniform field, that shows the differences in pixel-to-pixel sensitivity, and noise caused by the dust and debris.
- Once a flat field is taken, it can be divide out in the stacking process, to get a clearer image.
Flat Field

- A lightbox provides an artificial uniform light source
- The lightbox has two main components:
  - LED array: 4x4 6000 Angstrom lights to mimic sun
  - 2 mm frosted plexiglass in order to diffuse light into uniform light source
- Our lightbox has not yet been tested, but will be used soon
Stacking Photos

• Take the image data and subtract the dark and the biases, then divide by the flats.

• After the noise has been removed the images need to be corrected for the Earth’s rotation.

• This is done by finding how much each image has shifted from original and realigning them.

• The last step is to combine all the pictures

• Stacking is important because it allows you to see fainter objects.
Conclusions

The Robbins provides students:

◦ Hands-on experience with instrumentation
  ◦ Telescope operation, stacking images, noise calibration

◦ incredible potential for undergraduate research
  ◦ Example: Discovery of M66, a Type II Supernova

◦ potential collaborations with Chile, Japan, and Hawaii research groups and observatories
Future Work

- Collaboration with Sanda-Shounkan high school in Japan on Professor Itoh’s research on Asteroid 5404 Uemera
- Collaboration with Dr. Demarco at Universidad de Concepcion, Chile
- Herbig variable star research
- Collaboration with Gemini North in Hilo, Hawaii
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