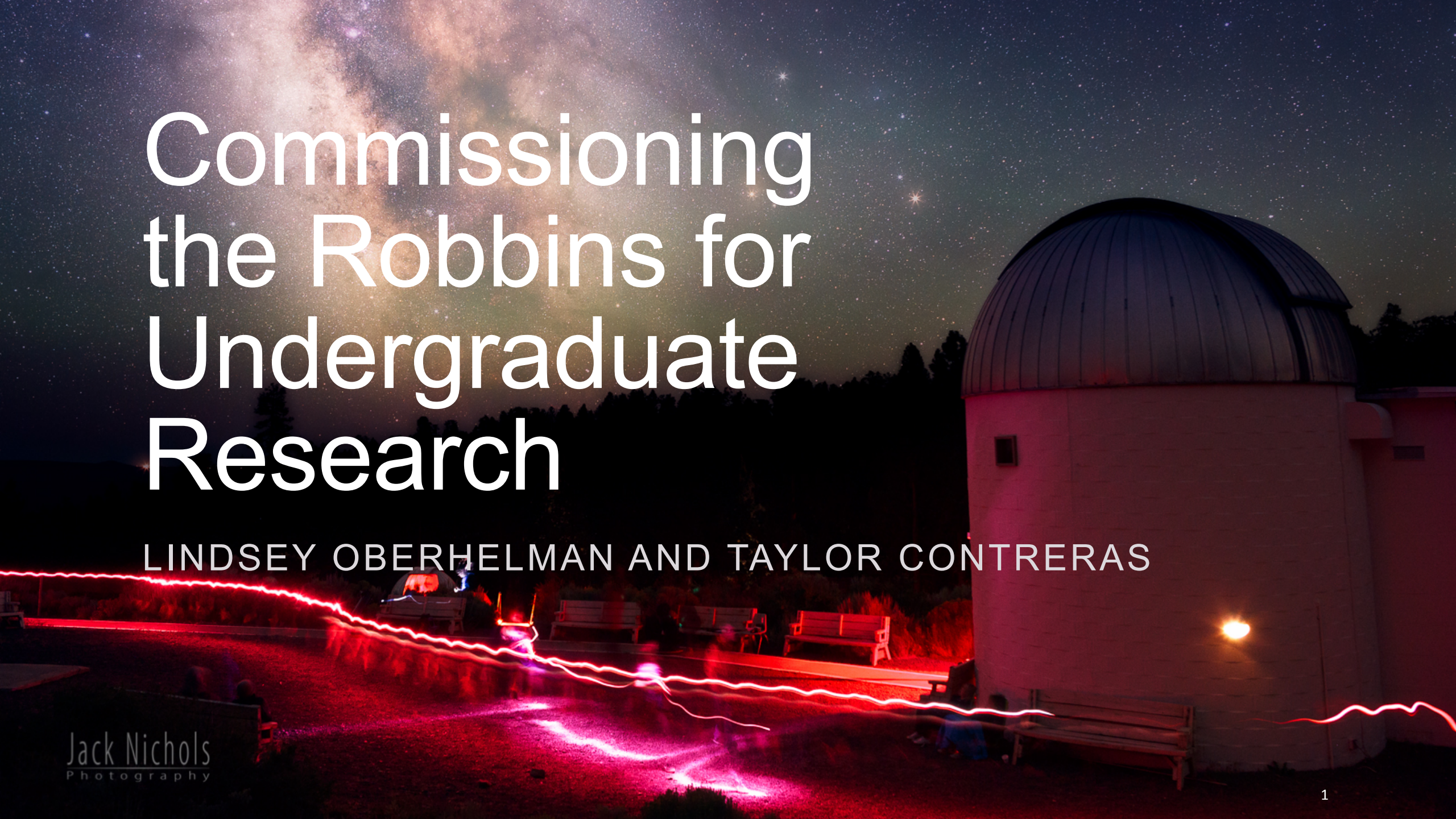
Commissioning the Robbins for Undergraduate Research

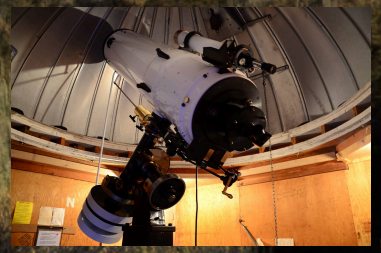
LINDSEY OBERHELMAN AND TAYLOR CONTRERAS



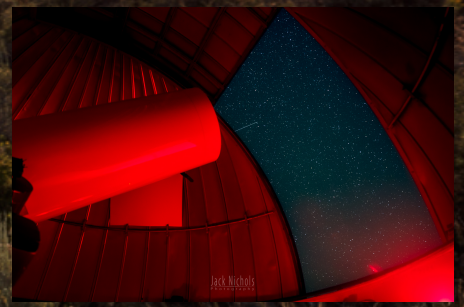
- Location: Central Oregon (30 min East of Bend)
- Great viewing due to:
  - Dry climate
  - Cold nights
  - Altitude: 6300 Ft

Pine Mountain Telescopes

14 inch (Robbins)



15 inch (JW Fecker)



24 inch

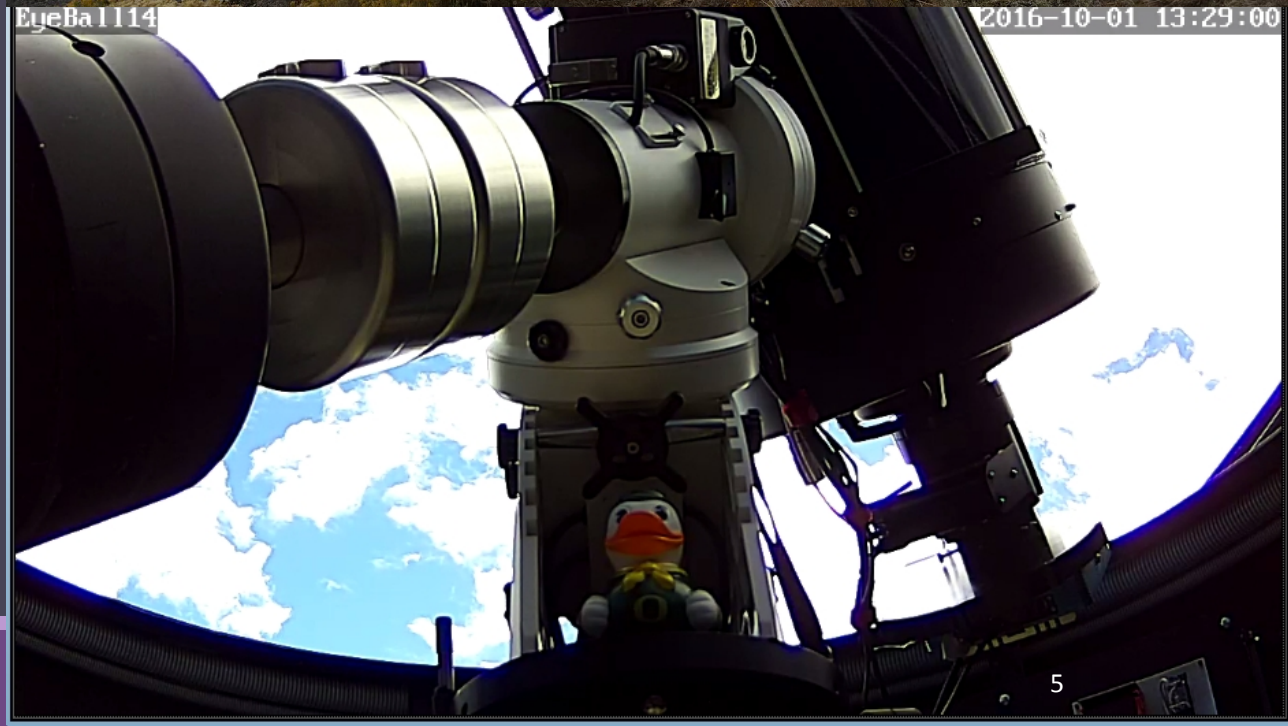
Public Nights

- 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

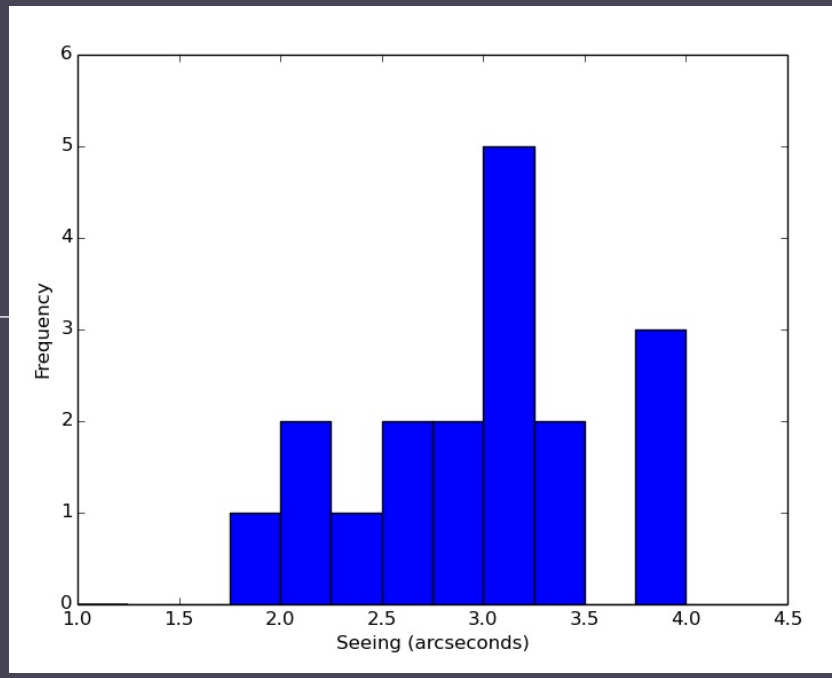
Learned to operate Robotic Telescope

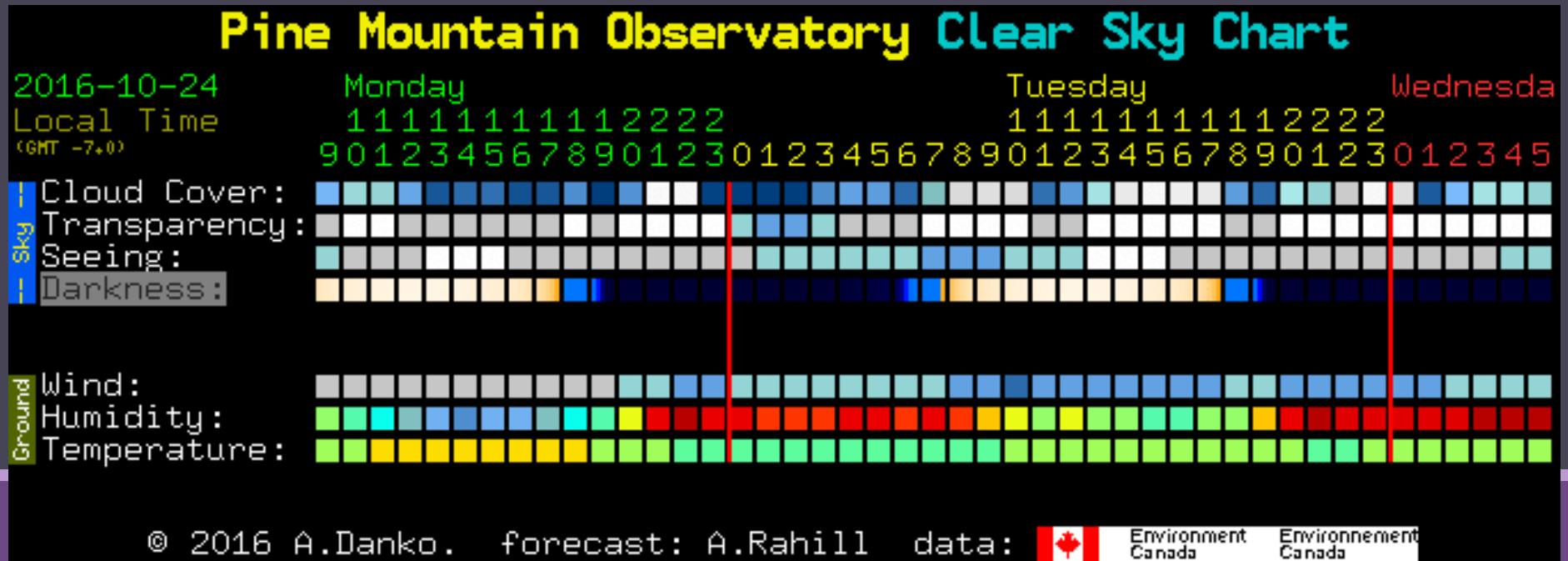
LT Date	11:35					
UT Date	6:35 AM					
Observers	Miller, Contreras, Fisher, Luken, Rose, Oberhelman					
Telescope	0.3m RoboScope					
	Local Time	Sky	Temp	Hum		
Weather	11:35	Clear but bright moon	44.99	58%		
Weather	12:04	Clear but bright moon	43.98	62 %		
Weather						
File prefix	PMO20160715S					
UT Start	File	Target	Exposure (sec)	Filter	Image Type	Comments
		HIP 105102				4.2 mag 6900 3 arc seconds
06:56	1-20	M15	3	R		7000 counts file
07:04	21-40	M15	3	G		33,36 had good seeing
7:08	41-60	M15	5	B		
07:13	61-80	M15	1	Lum		Not perfect focus 5.4 C
07:15	81-82	M15	1	Lum		BAD
07:20	83-102	M15	1	Lum		New focus is 6700 5.4C
7:33	103-122	NGC457	0.2	Lum		Owl cluster open cluster 116,117 real good
07:35	123-142	NGC457	0.4	R		

Site Characterization

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

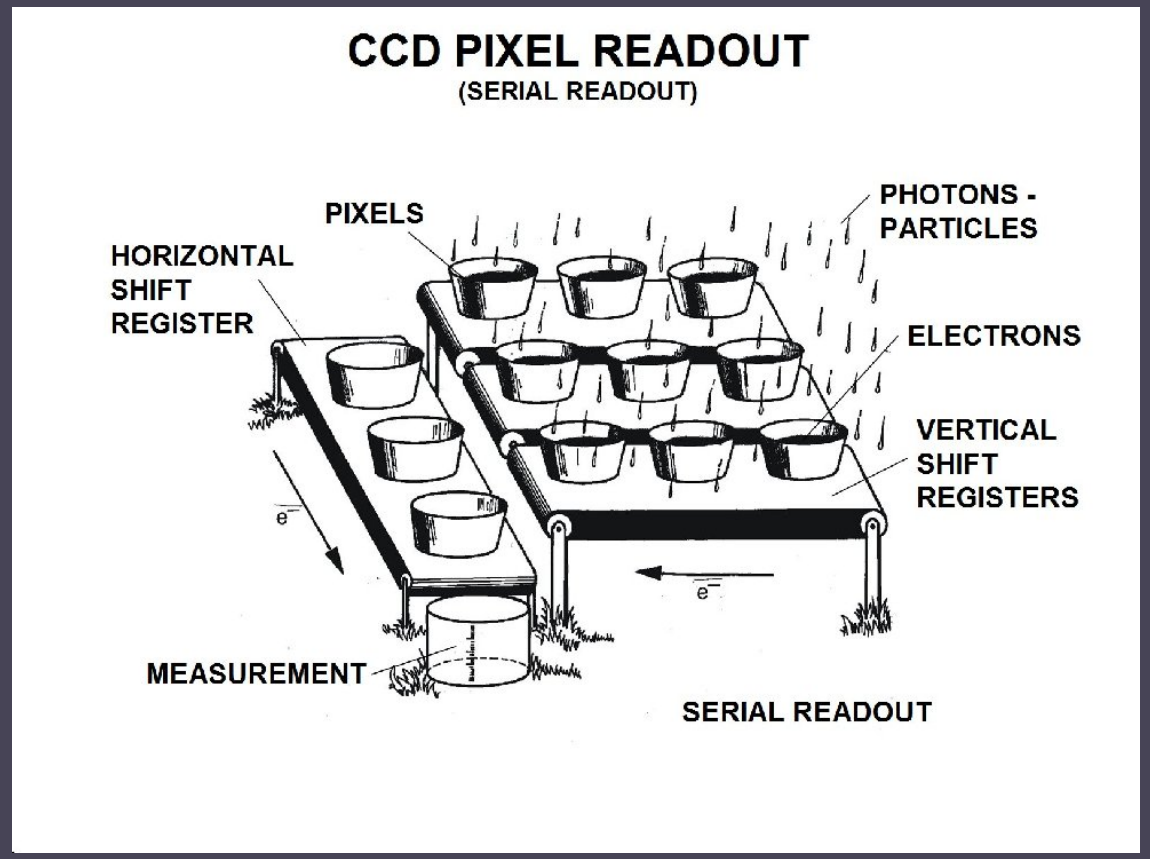
With more data, we will be able to match clear skies' seeing scale (0 to 5, with 5 being the best), to the Robbins seeing abilities (in arc seconds).





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

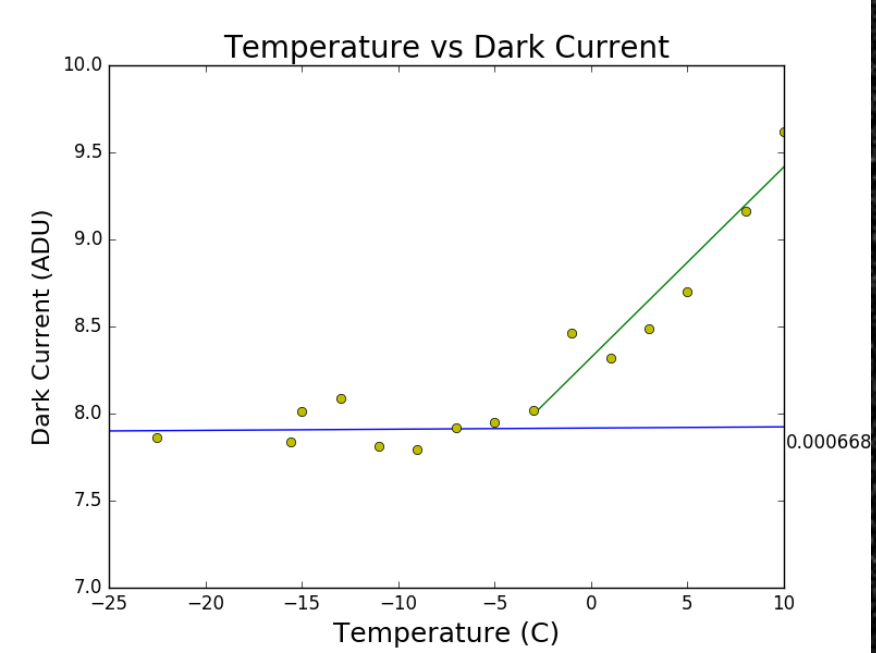
Biases

- 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

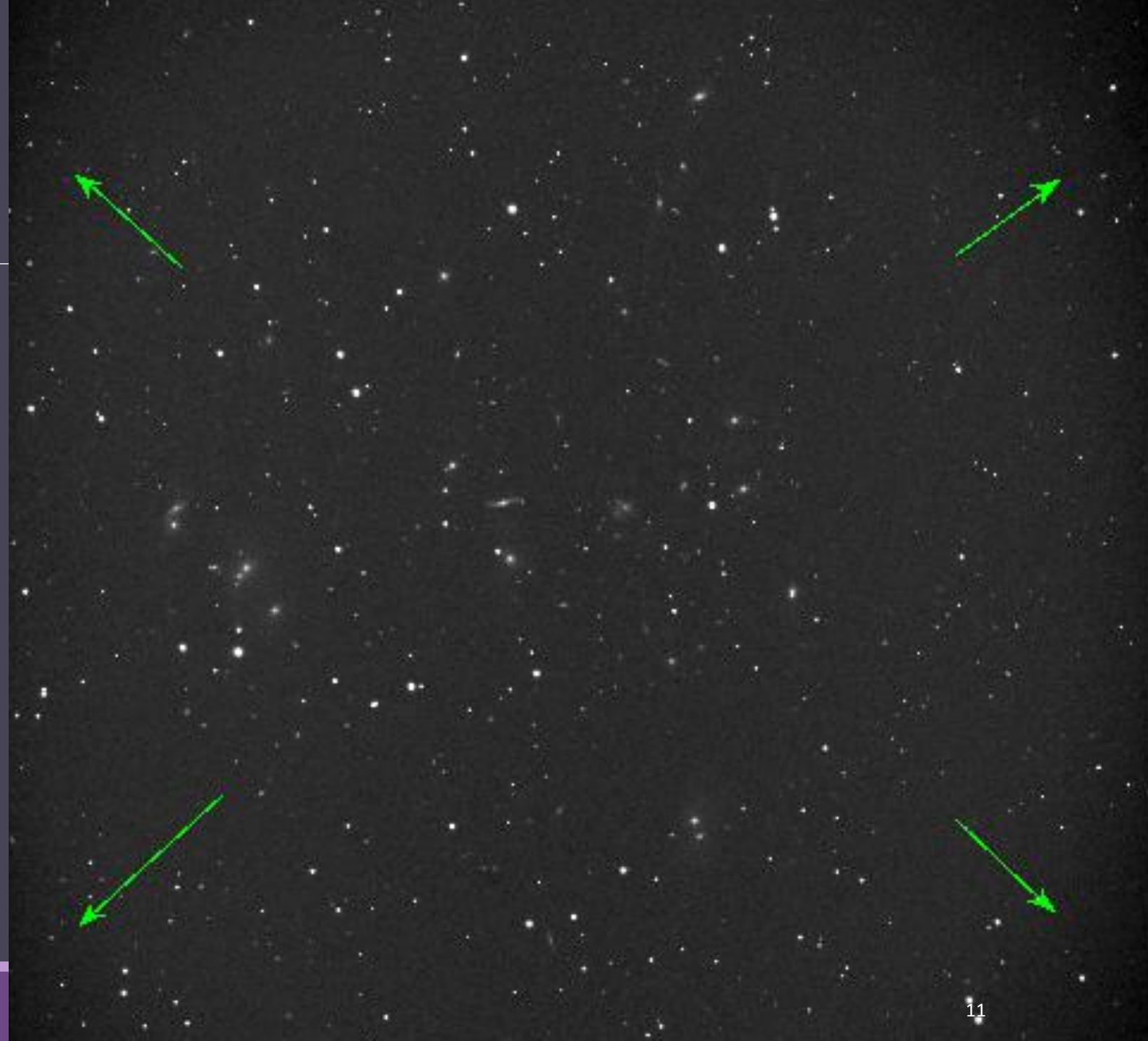
Dark Current:

- 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



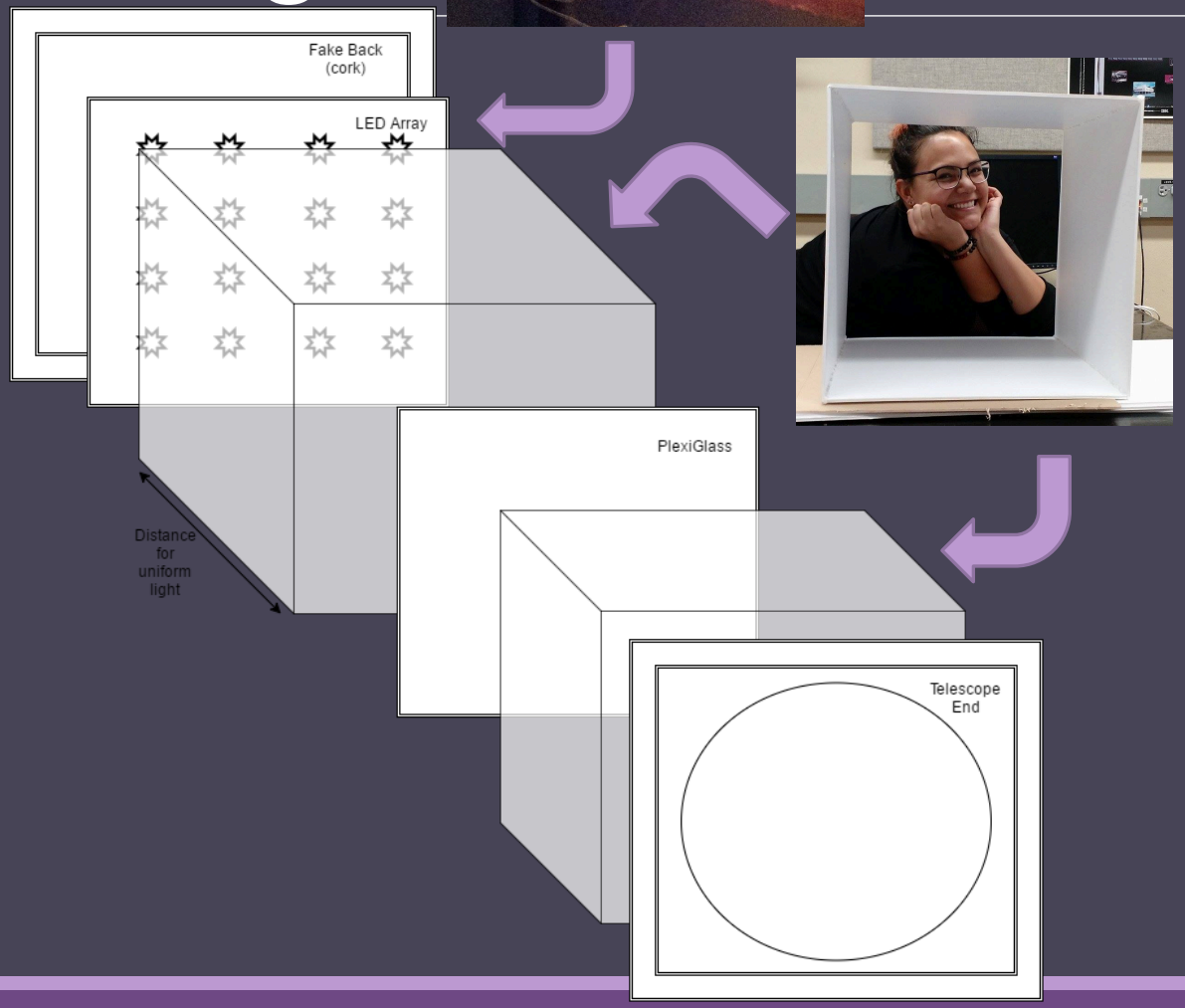
Flat Fields

- 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 take, it can be divide out in the stacking process, to get a clearer image



Flat Field

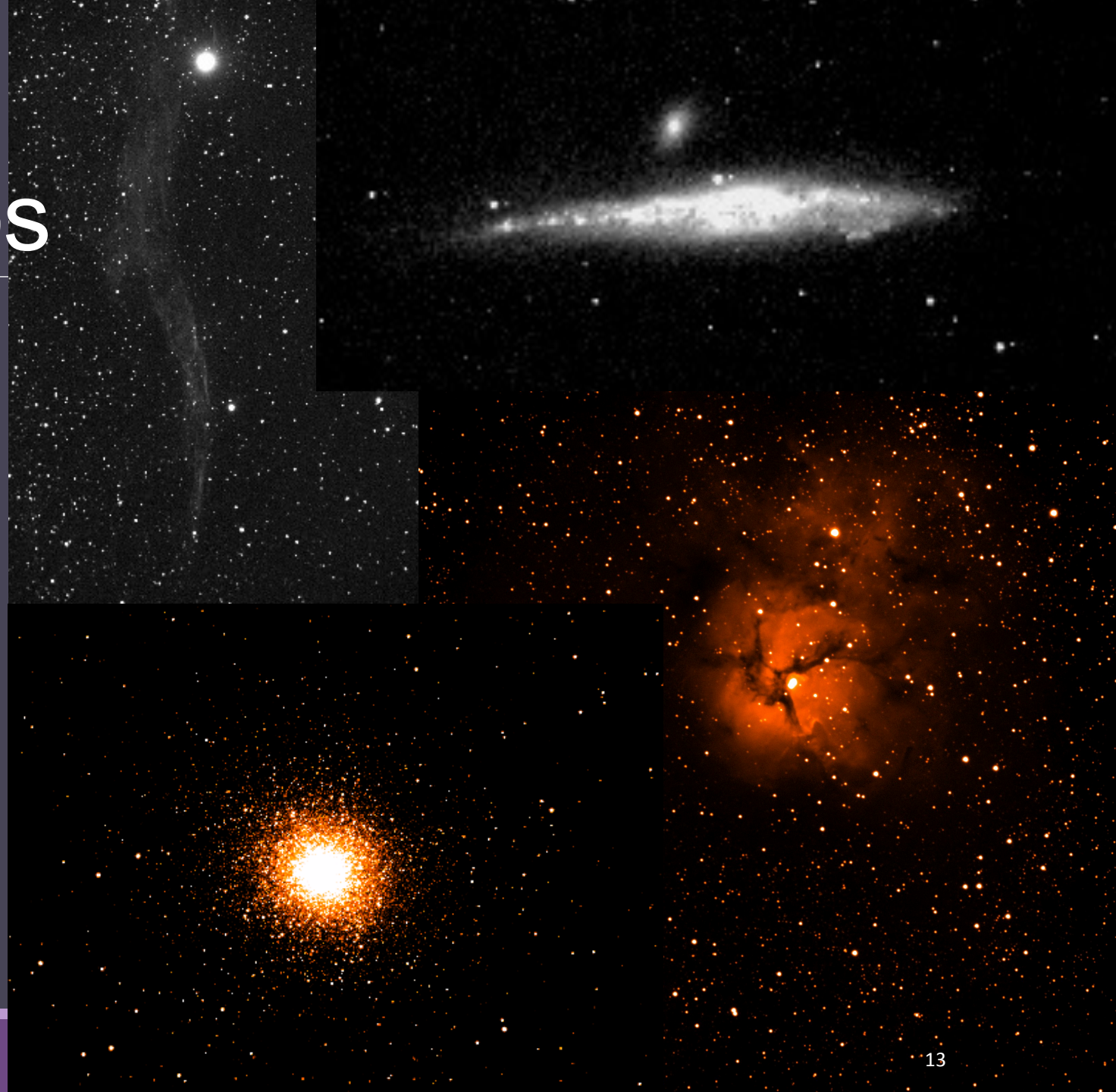
Light



- 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

Acknowledgments

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