



# Local Weather Observation Using Daytime Astronomy

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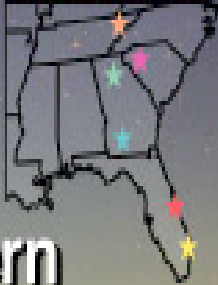
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*<http://www.astro.fit.edu/sara/sara.htm>*

# *Primary Goals*

- To determine filters that optimize daytime observation of stars
- Once filters are determined, create a user range of magnitude for optimal viewing conditions

# In order to begin observation...



- The dome had to be prepared for use after a long period of sitting
- Though not mechanically controlled, manual movement was improved
- Once Improvements were made, equipment went in

- Equipment consisted of two computers to be used as controllers and an STV video camera and Autoguider
- Computers are to operate Bisque's "The Sky" and to save images from the STV
- (Though remote operation of the STV is possible)





- The telescope originally planned to be used was the Celestron Nexstar 5-in aperture telescope

- Technical difficulties prevented the use of the Nexstar until early autumn

- A Celestron 8-in Cassegrain-Schmidt telescope was aligned and used for the collection of data

[f/10 2000mm focal length]



# The STV...

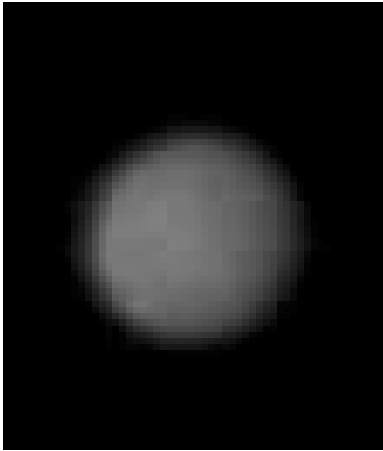


- The STV is a unique and versatile instrument that has many exceptional abilities
- It is a highly sensitive, cooled, digital video camera
- Abilities include autoguide and image without the need of a computer and an RS-232 port for remote control and Image Download

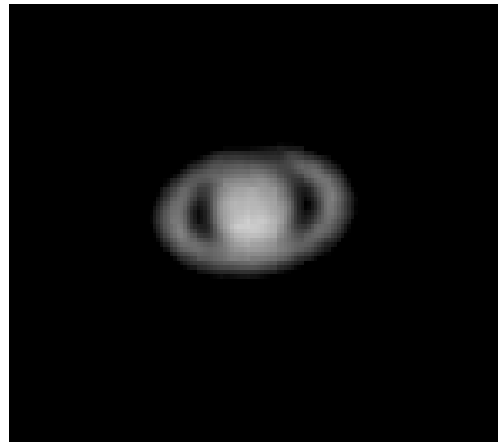
## Some of the STV Specifications

- Image Modes: Wide = 656 x 480 binned 3 x 3  
Normal = 640 x 400 binned 2 x 2  
Zoom = 320 x 200 binned 1 x 1
- Exposure Times: 0.001 to 600 seconds
- Cooling: Single Stage thermoelectric - 25 degrees C from ambient
- Image bit depth: 10 bits for 1 x 1 binning mode  
Up to 16 bits for other binning modes
- Built in Track and Accumulate
- Internal lunar filter (green)

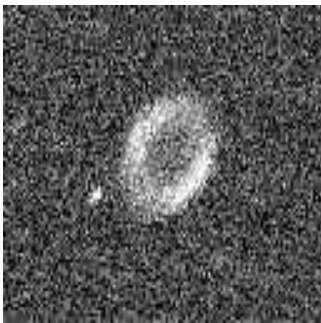
# Some of Our STV Images...



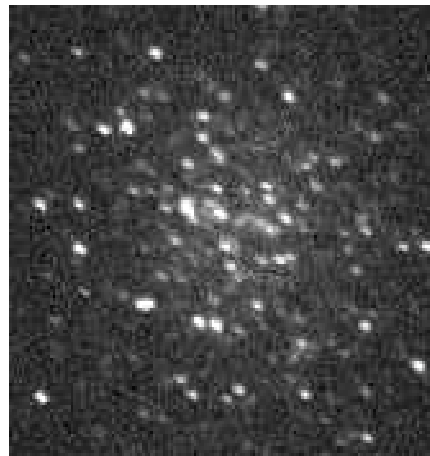
Mars



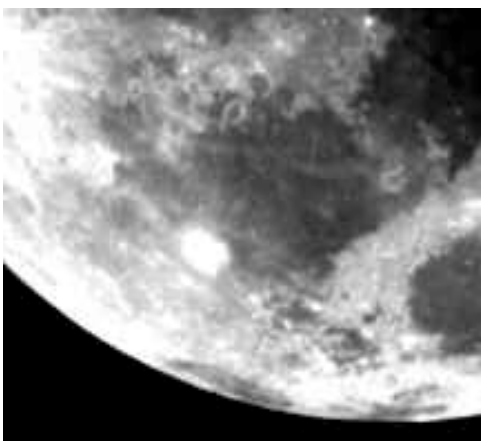
Saturn



M-57



M-13



Moon

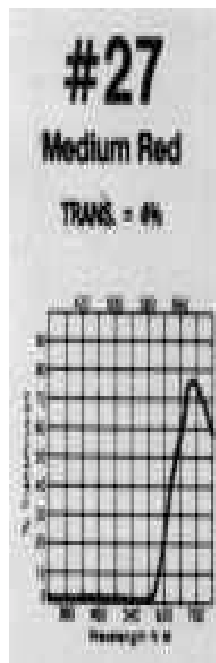
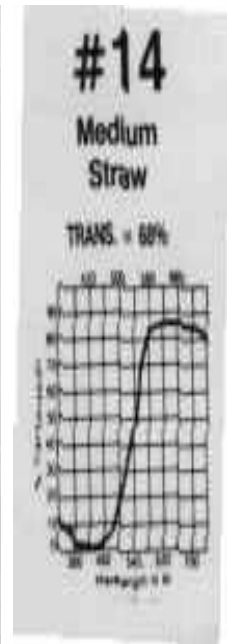
# Observations

- In order to observe stars during the day we must determine which filters to use to block out the ambient sunlight

- The filters chosen were celophane filters : Indigo, primary green, medium red, yellow, and deep amber

- Prior to actual observations our hypothesis was that the red filter would produce the best results

- These are the filters chosen to try...



These graphs are transmission vs. wavelength

- Another concern was whether our filters would have a low enough transmission of light

- The lowest transmittance of our filters was 2% (Indigo) and the highest was 68% (Yellow)

- The sun overwhelmed many of our first filters before it even peered over the horizon, so we only used filters that had ~10% or less transmission

- You can see here the image of a star without a filter in place...



Aldeberan at 0555

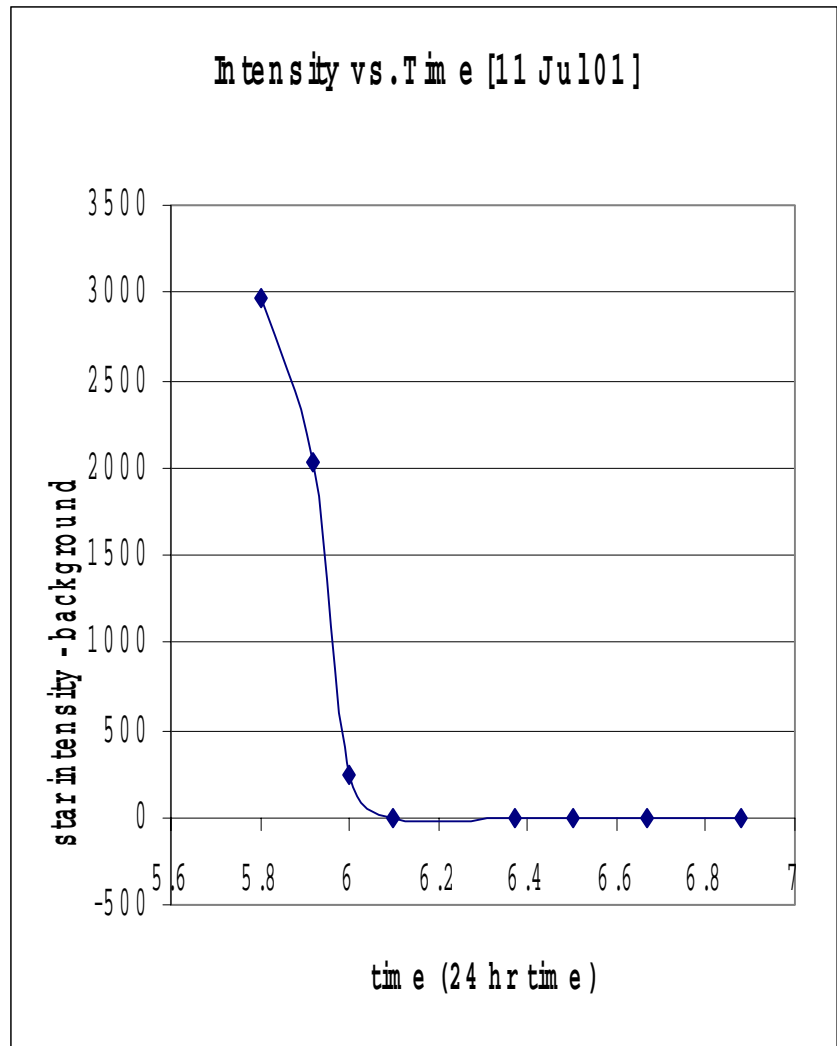


Aldeberan at 0600

The image is nearly overtaken by the sun in a mere five minutes after the first picture

# Data

- First notice the graph of the background subtracted from the Aldebaran's intensity without a filter in place and a 1 second exposure
- The star is not discernable from the background after about 6.1 hrs (0606 hrs)
- On 11 Jul 01 the sun rose at 6.42 hrs (0625)
- So twilight interferes with star observation even while the sun is ~4 degrees below the horizon!

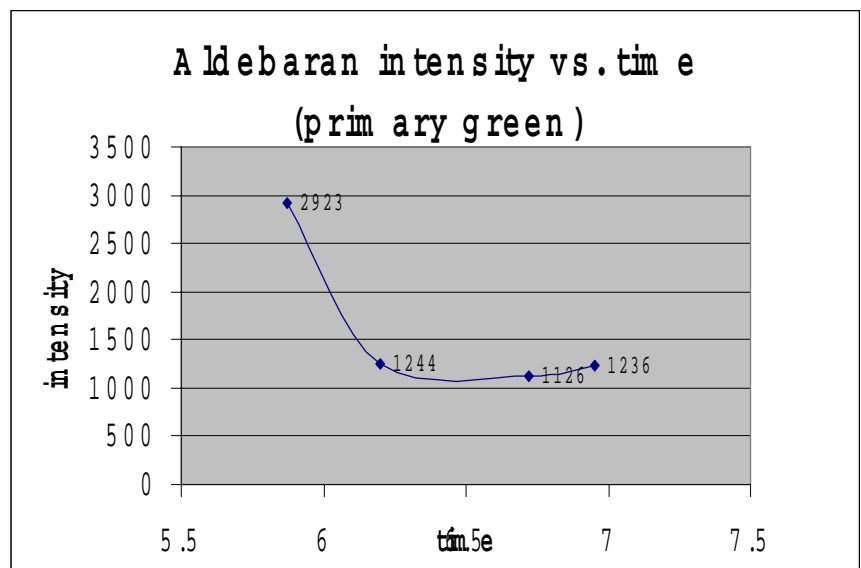
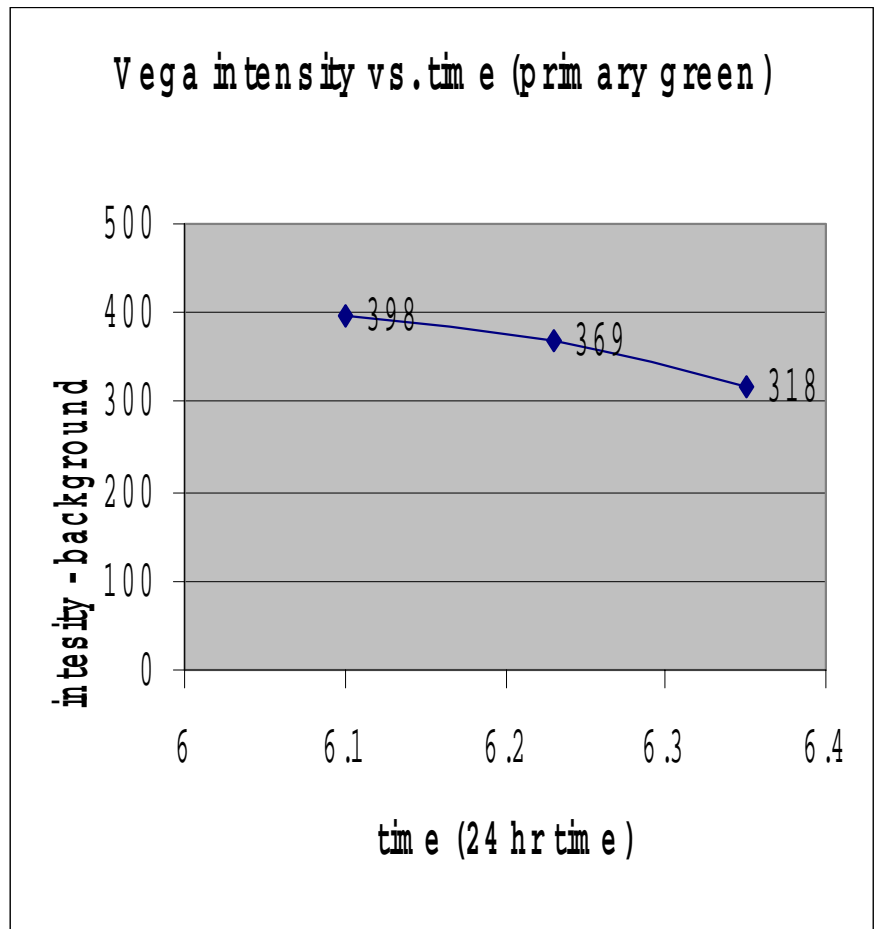


- The primary green filter had a transmittance of 7%

- This graph represents Vega's intensity subtracted from the sky with the green filter

- Note that the difference is smaller due to the 2 sec exposure time causing the background to be more intense

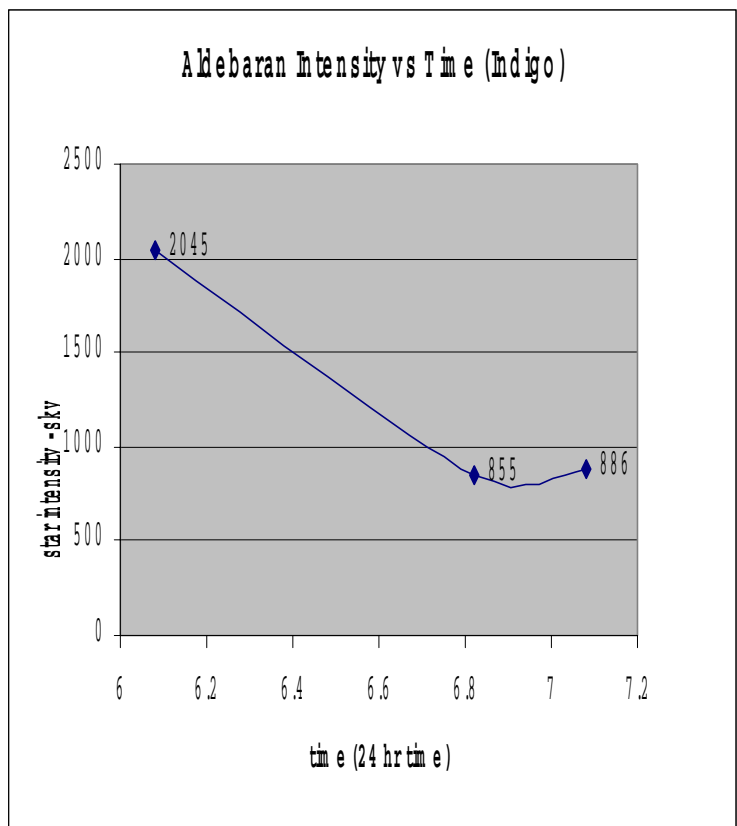
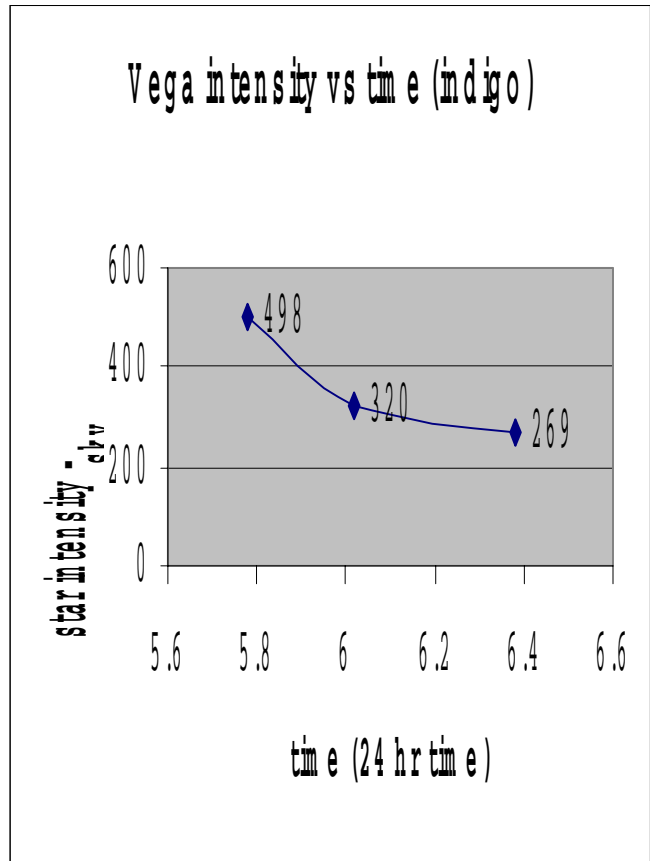
- Aldebaran shown here has a similar pattern although the image had a lower exposure time (.10 sec)



- The Indigo filter (2% transmission) portrayed here shows Vega through 6.4 hrs (0624) also a 2 sec exposure

- Note how the star can still be differentiated from the background light, though not as well as the green filter shown previously

- Aldebaran through the Indigo filter at a .10 sec exposure has a similar pattern including having lower contrast

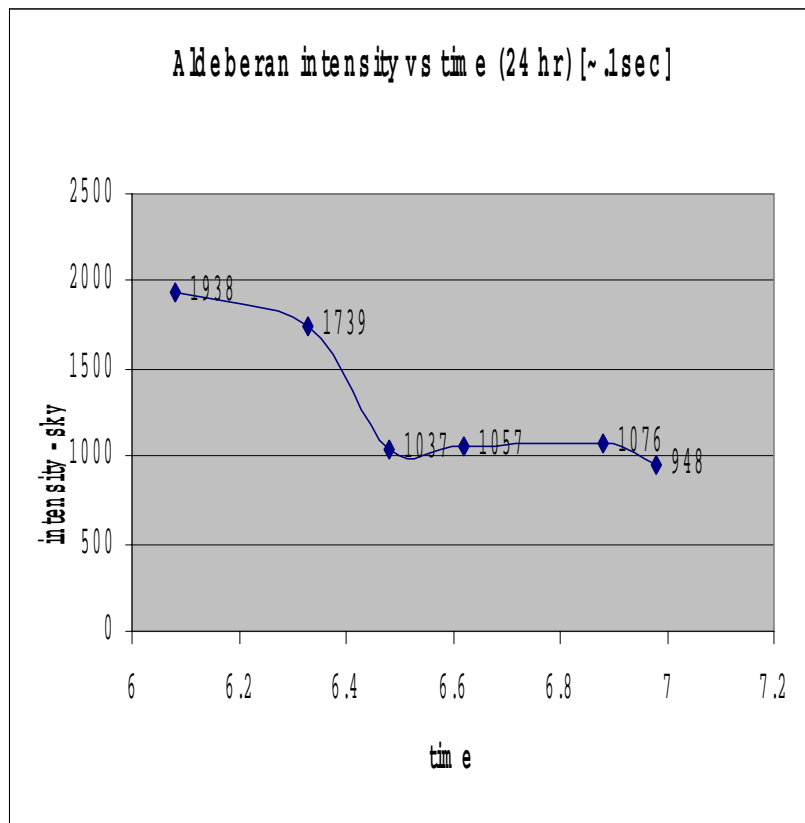
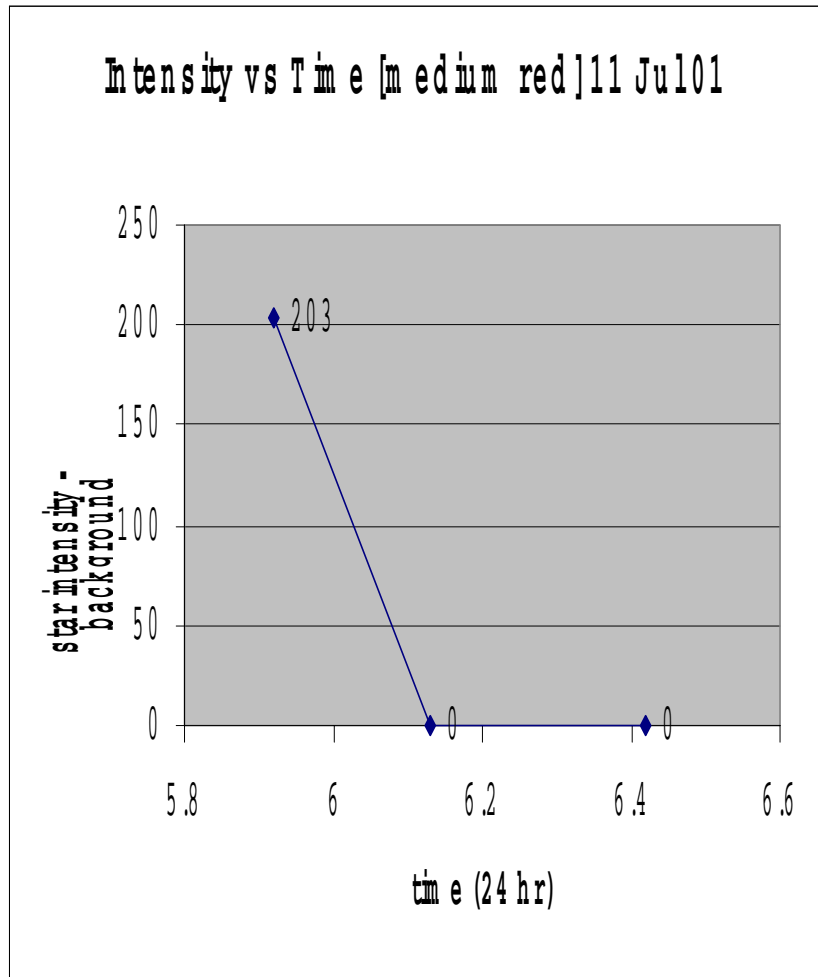


- The medium red filter (~400 nm) with a 4% transmission produced these graphs

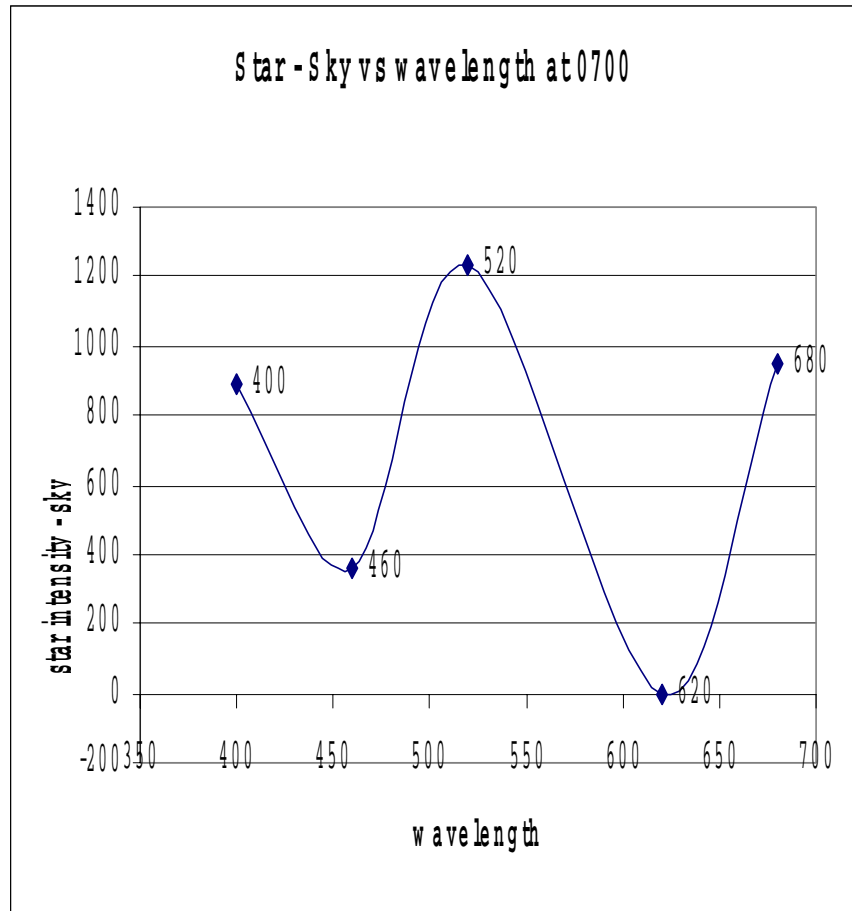
- Note how Vega is no longer discernable past ~6.13 hrs (0608 hrs) at a 2 sec exposure

- Yet, Aldebaran is apparent with an exposure of ~.10 sec

- Though apparent, it is still of less contrast than the green and similar in contrast to the Indigo



- To get another perspective on the same data, this graph shows five filters attempted on 11 Jul and at approximately the same time
- From this data one can see that in the visible spectrum, the green filter (~520 nm) gives the best contrast for daytime observation



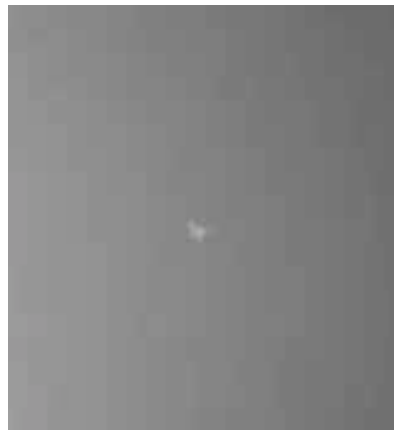
v      b      g                  y      r

# Results

- The filter that seems to provide the best contrast is the primary green filter (465-560 nm)

- The filter that proved to have the poorest contrast was the medium red filter (640-740 nm) although it was not far worse than the Indigo filter

- By far, the most astounding result of this research was to successfully image stars during the day!



Aldebaran  
0700

- The stars observed, Vega and Aldebaran, are some of the brightest stars in the sky and with fainter stars there will be a lower contrast value due to the smaller difference of the stars' intensity with respect to the background light

- Vega (0.00 mag) and Aldebaran (0.00 mag)

- Vega: RA: 18h 36m 56.0s Dec: +38°47'01"

Spectral: A0Vvar

- Aldebaran: RA: 04h 35m 55.0s Dec: +16°30'32"

Spectral: K5III

# Discussion:

- Our initial hypothesis for the filter to be red was an incorrect hypothesis, so we attempted to explain why the filter that proved to be the best turned out to be the green filter.

- One possible conclusion is that the blue is scattered in the atmosphere by the molecular oxygen and ozone while the red may be scattered by various airborne debris such as dust or other particulate

- Though this hypothesis has not been verified, it does seem to address the better contrast in the green wavelengths as compared to the Indigo and the Red filters

- Though the goal of the summer was to implement a Nexstar 5-in telescope in our research, technical difficulties prevented its use
- This added to an already difficult task, for now we could not just type in the star to find during the day
- We had to begin tracking the stars at sunrise with an older telescope, the Celestron 8-in

- Data was still taken with the Celestron, but we could not track many of the stars on our bright star list due to the fact that they either rose after dawn or set before dusk



Venus @  
1400

- The overall goal for the summer was to determine filters to view stars during the day

- This goal was achieved even though we had obstacles to overcome

- We averaged two to three good days of viewing a week although summer haze was present



- With more data being taken, the user defined range of magnitude will be determined and the OVIEW project will be in full swing