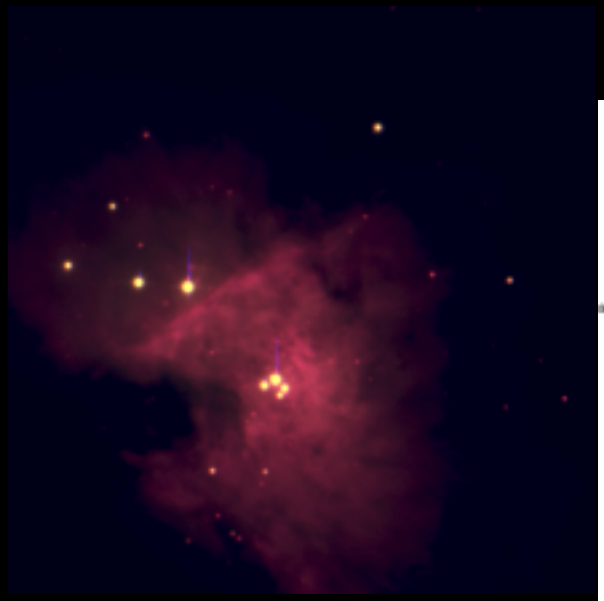
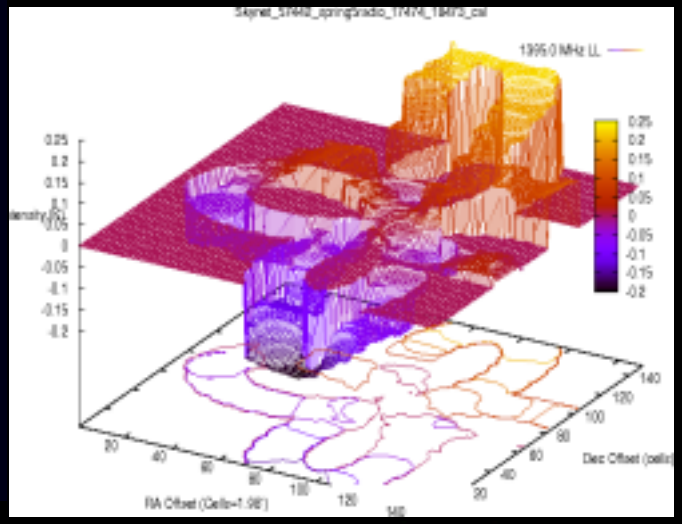
# SJS PD Group Project Examples






# Group 1

# WHAT CAN STAR COLOR TELL US ABOUT AGE OF A CLUSTER?


# What can we learn about star clusters by comparing individual stars through different filters?

Let's compare globular clusters and open clusters.

Hypothesis: Globular clusters are old. They will contain more red stars (that is stars that are older) than blue stars. Open clusters will not follow this trend. Visual inspection will be reasonably reliable in determining "old or young" clusters.

# Method

- Select 1 Open Cluster and 1 Globular Cluster each.
- Set up each Optical Observation on a telescope with 3 different color filters.
- Using Astro Image, produce color images. Visually identify any prominent star color trends.
- Verify visual determination of selected Red, Yellow and/or Blue Stars by photometer measurements in Afterglow.
  - Record Flux in each of the 3 stars for each filter.
  - Compare Photometer Flux results for each star to the color image to see if flux results match the color determinations made from visual inspection.
- Record Star Cluster approximate ages to determine if the dominantly observed star color correlates correctly to our predictions based on star flux and color.

# Open Cluster Data

| Source/ Age | Selected Star Coordinates | Visual Color Observation of Star | GenB Star Flux | GenG Star Flux | GenR Star Flux | Does our visual identification match the flux readings? |
|---|---|---|---|---|---|---|
| M44 - 650 Million<br><br>Mostly blue cluster. | 1: 466.49,573.49 | Yellow | 5,877,071 | 6,160,753 | 6,714,667 | More red than yellow. |
| | 2: 786.51,244.45 | Yellow | 5,193,411 | 5,744,836 | 6,148,554 | More red than yellow. |
| | 3: 510.17,218.92 | Blue | 4,046,350 | 3,451,030 | 2,671,442 | Confirmed |
| | 4: 252.49,697.83 | Blue | 6,235,34 | 5,600,687 | 4,810,980 | Confirmed |
| M50 – 78 Million<br><br>Mostly blue/yellow cluster. | 1: 787.18,740.30 | Yellow | 918,047 | 1,153,07 | 1,553,553 | More red than yellow. |
| | 2: 741.92,506.53 | Yellow | 37,862 | 71,175 | 145,128 | More red than yellow. |
| | 3: 456.14,246.53 | Yellow | 242,126 | 504,092 | 837,195 | More red than yellow. |
| | 4: 422.10,537.41 | Blue | 696,855 | 572,332 | 428,157 | Confirmed |
| | 5: 494.03,650.88 | Blue | 1,191,789 | 1,016,317 | 866,543 | Confirmed |
| M35 – 100 Million<br>Mostly yellow cluster. | 1: 987.49, 709.22 | Yellow/Blue | 3,083,390 | 2,766,233 | 2,411,664 | More blue than yellow. |
| | 2: 667.50, 157.99 | Red | 2,399,403 | 2,676,870 | 2,990,398 | Confirmed |

# Globular Cluster Data

| Source Name / Age/Image | Selected Star Coordinates | Visual Color of Star | GenB Star Flux | GenG Star Flux | GenR Star Flux | Does our results predict the Cluster Age? |
|---|---|---|---|---|---|---|
| M5 – 13 Billion<br>Mostly red cluster. | 1: 632.01,345.92 | Red/Yellow | 6,431 | 11,080 | 19,484 | Confirmed |
| | 2: 612.61,696.38 | Yellow | 602 | 1500 | 1274 | Confirmed |
| | 3: 459.85,622.24 | Red/Yellow | 5,682 | 8,466 | 13,089 | More red than yellow. |
| M10 – 11.4 Billion<br>Mostly red cluster. | 1: 626.81,512.60 | Red/Yellow | 50,503 | 83,778 | 136,058 | More red than yellow. |
| | 2: 390.59,524.53 | Yellow | 61,182 | 105,125 | 61,182 | Confirmed |
| | 3: 416.12,477.59 | Yellow | 21,297 | 35,737 | 61,065 | More red than yellow. |
| | 4: 343.57,594.27 | Blue | 24,573 | -2609 | -1903 | Confirmed – Anomaly due to presence of "Blue Straggler" (results from star interaction in dense cluster, not actual blue star). |
| M68 – 11.2 Billion<br>Mostly red cluster. | 1: 205.92, 698.73 | Red | 7,198 | 24,006 | 106,422 | Confirmed |
| | 2: 232.74, 702.05 | Yellow/White | 66, 329 | 83,390 | 112,053 | More red than yellow. |


# Trends & Results

- Open Clusters had stars more visually discreet stars than Globular Clusters.
- As a group, we incorrectly made a visual color assignment to stars 50% of the time.
- Batch photometry is the key tool for identifying a star in all three filter Afterglow images when the star is only easily identifiable in one.

Our hypothesis is partially confirmed: Open Clusters contained more blue and yellow stars, while Globular Clusters contained more red stars. However, visual inspection was not the most reliable color assignment method.

# Further Questions

- If we were to repeat our observations and produce additional color images, could a change in the atmospheric conditions change our color identity reliability?
- Would we have the same success rate visually identifying star color in a nebula?
- Could we use predominate star color to determine relative age for galaxies as well?
- Can the approximate age of the star cluster be determined by the highest red or blue star flux readings?

# M44 – the Beehive Cluster

Blue/yellow stars dominant – indicates younger cluster.

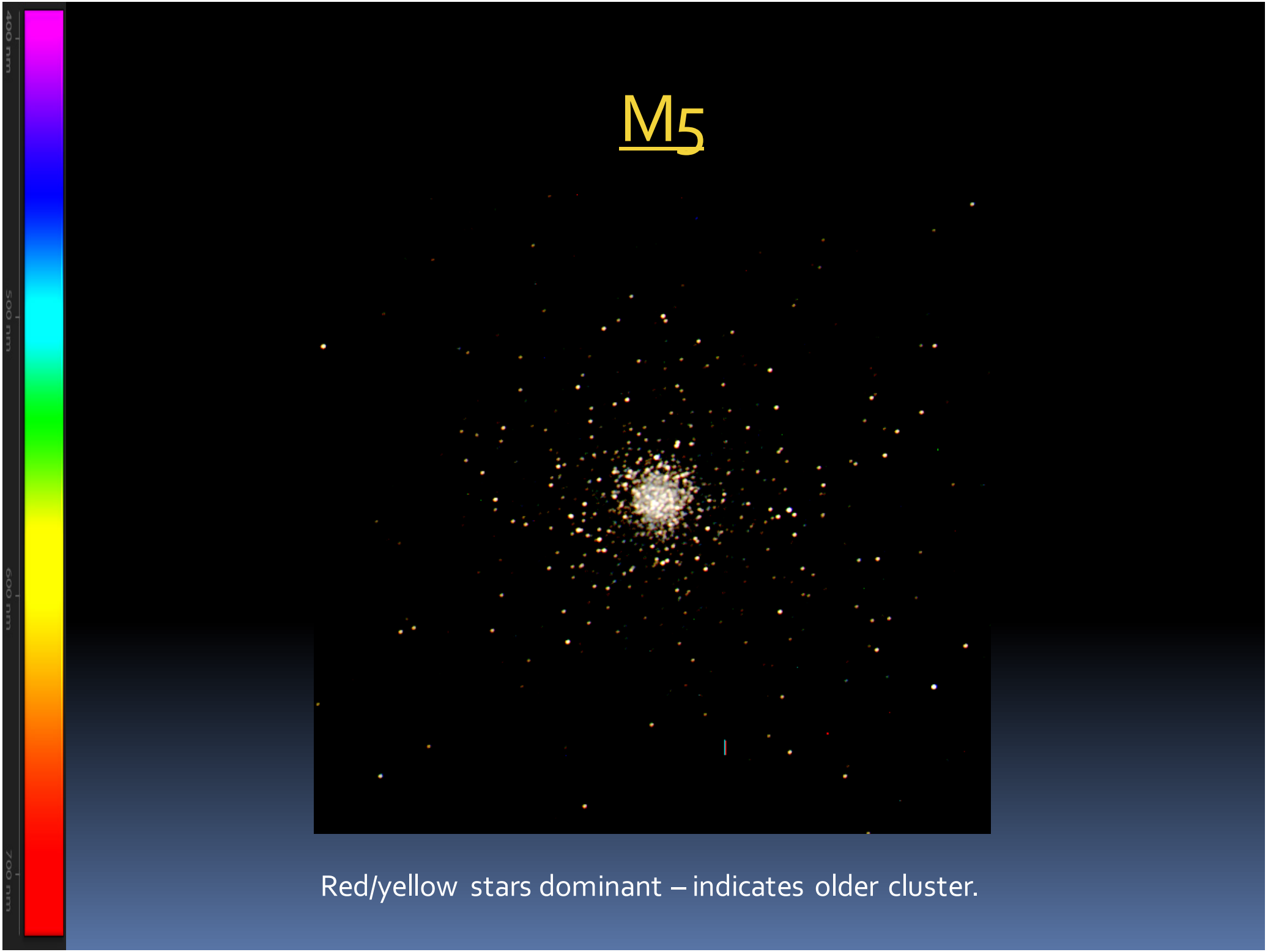
# M50 – Open Cluster

Blue/yellow stars dominant – indicates younger cluster.

# M35

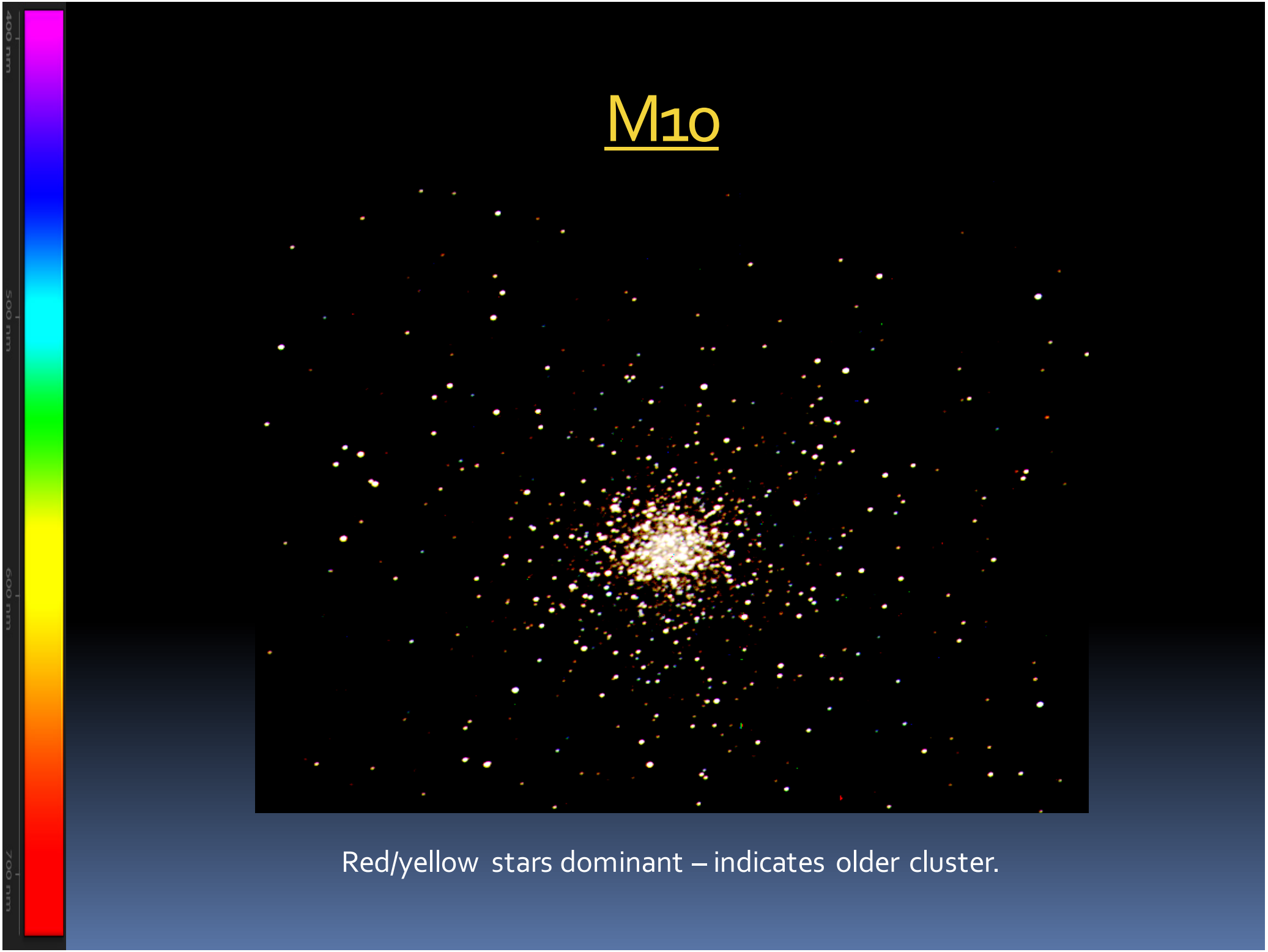
Blue/yellow stars dominant – indicates younger cluster.

# M5




Red/yellow stars dominant – indicates older cluster.

# M10



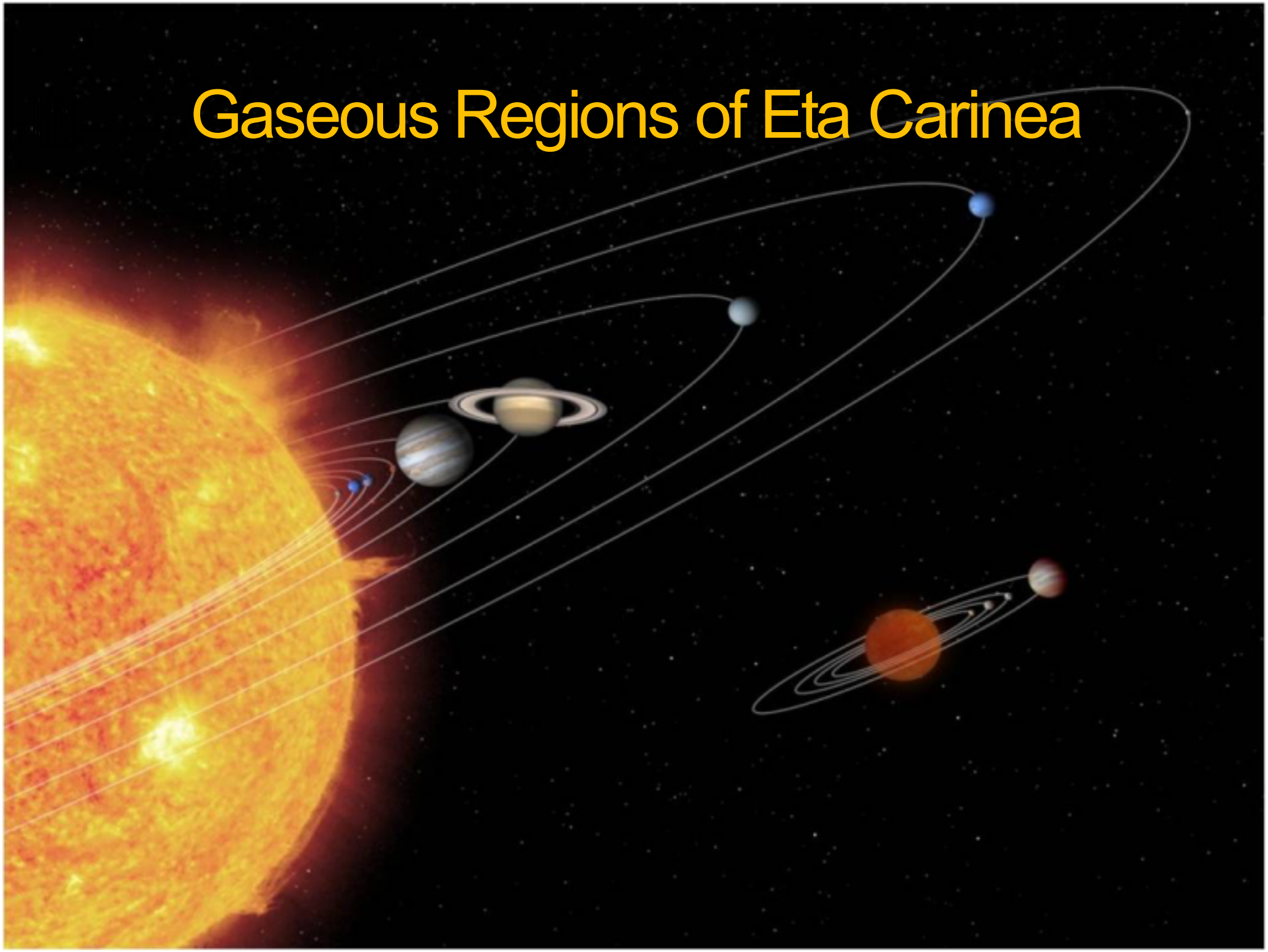

Red/yellow stars dominant – indicates older cluster.

# M68

Red/yellow stars dominant – indicates older cluster.

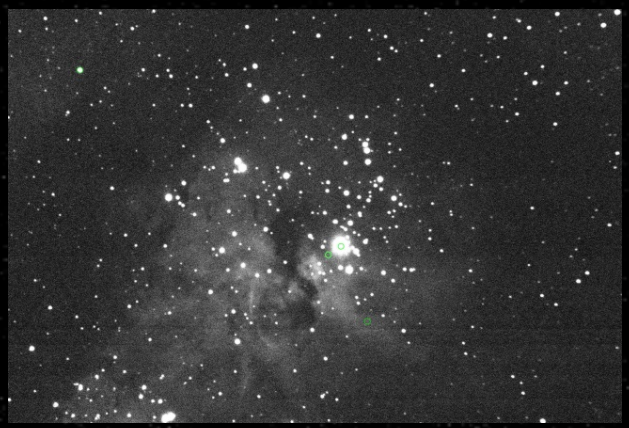
# Group 2

# Gaseous Regions of Eta Carinea



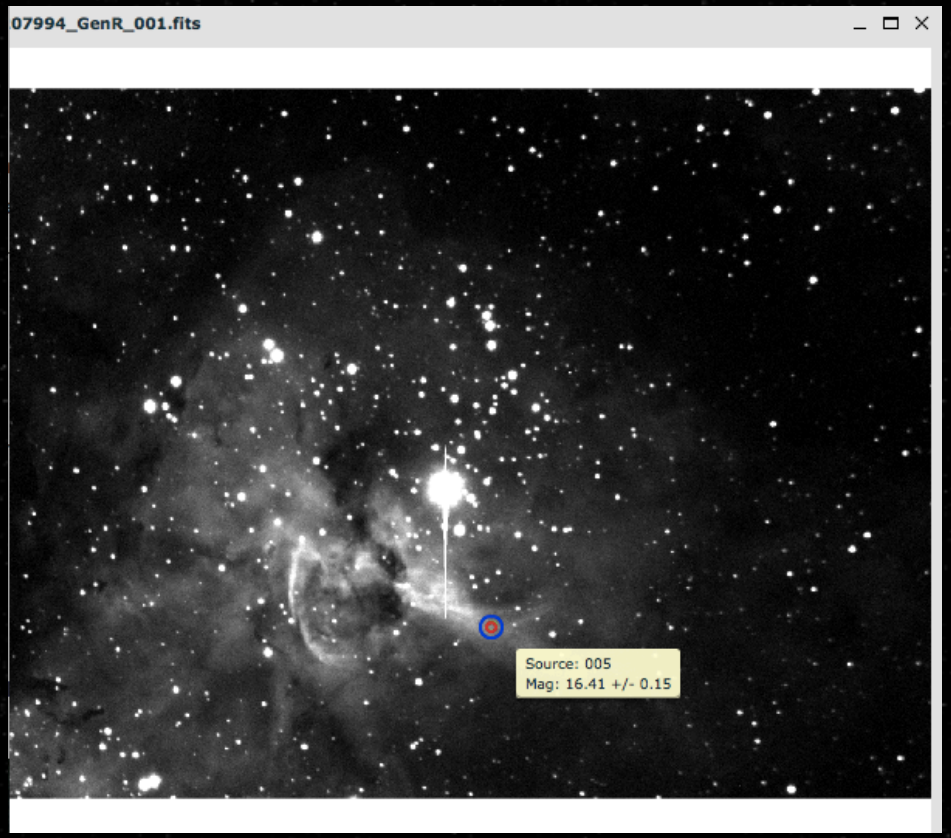
# Observation

When viewing R-G-B photos of Eta Carinea, we noticed that the gaseous regions were brightest with the red filter:



# Observation Validation

Through the photometry tool in Afterglow, we verified the observation:




| | Red | Green | Blue |
|---|---|---|---|
| Spot 1 | 16.41 | 18.37 | 18.00 |
| Spot 2 | 16.02 | 16.70 | 17.95 |

# Hypothesis

The source of energy for the gaseous regions of eta carinea is an external thermal heating process, not something generated by the cloud itself.

*If the cloud were generating its own energy, we would expect it to register more on the hotter blue end of the scale. The observation that it is relatively red and cool leads us to believe it is rather reflecting the heat of another highly energetic object.*

# Next Steps

Evaluate images using filters outside the visible spectrum.

*We would expect that if the object is being heated via thermal radiation, it will register strongly on the infrared and radio spectrums.*

# Group 3

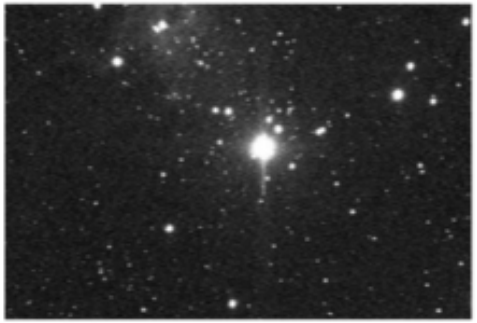
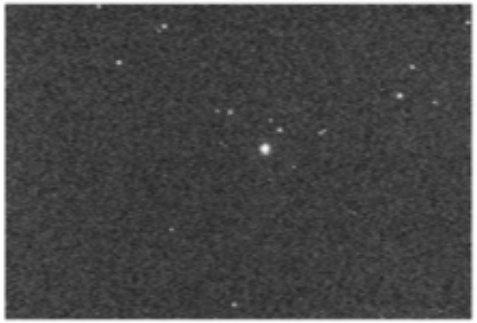
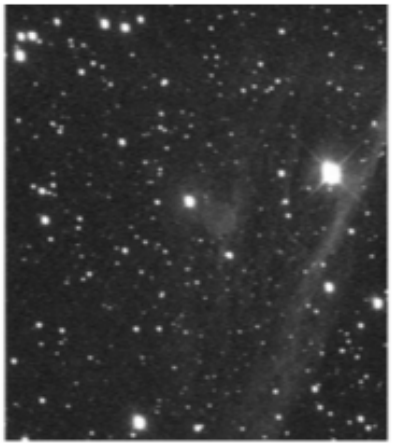
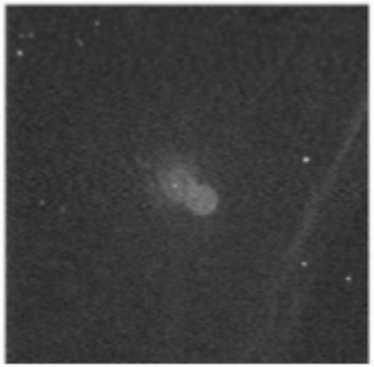
# The Presence of Oxygen in Various Nebula: A Skynet Junior Scholars Project

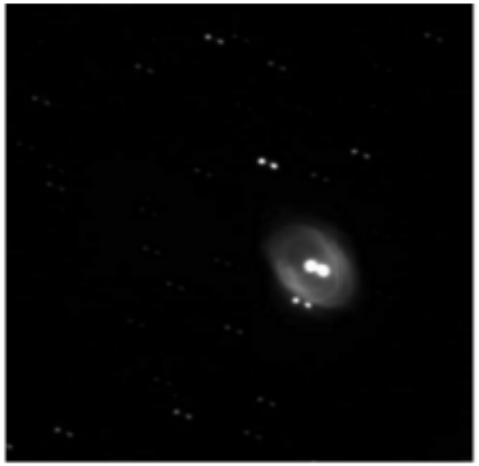
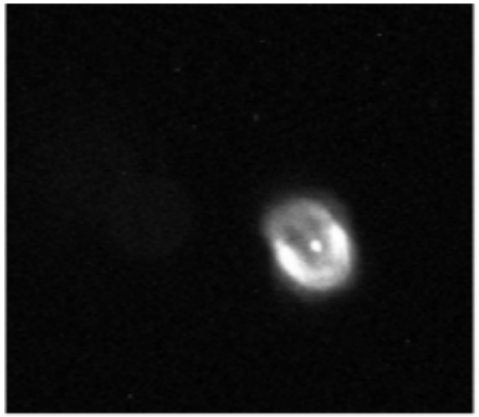
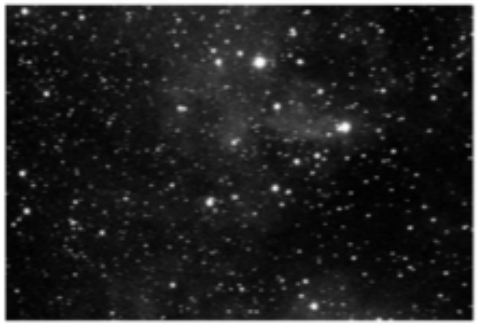
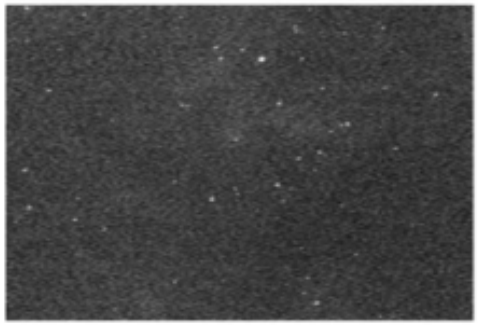
## Question

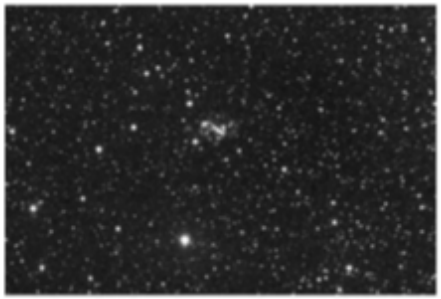
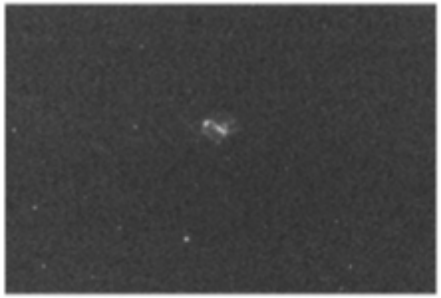
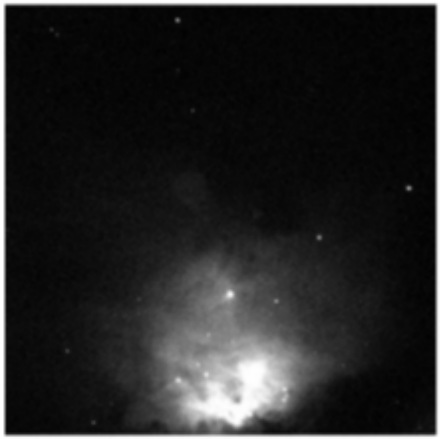
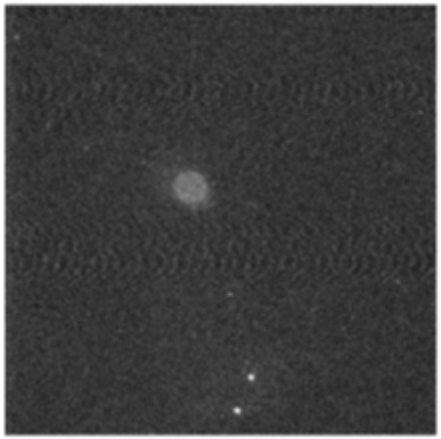
Which nebula have a strong presence of oxygen, which ones do not?

## Criteria

- Does the nebula standout better, worse, or the same when viewed through an OIII filter vs a standard, clear luminosity (HiThru) filter.
- If the answer is worse, then there is little to no oxygen present.

| Nebula Type | HiThru Image | OIII Image |
| --- | --- | --- |
| Emission Nebula NGC 2264 |  |  |
| Supernova Remnant NGC 2736 |  |  |

| Nebula Type | HiThru Image | OIII Image |
| --- | --- | --- |
| Planetary Nebula NGC 3132 |  |  |
| Emission Nebula Keyhole, with some Absorption dust |  |  |

| Nebula Type | HiThru Image | OIII Image |
| --- | --- | --- |
| Planetary Nebula NGC 5189 |  |  |
| Reflection Nebula M78...with artifact of planetary nebula from previous user...still showing up 5 minutes later |  |  |

Conclusion: Planetary Nebula have the strongest indication of the presence of oxygen based on the overall brightness/visibility in the OIII images. Supernova remnant have amounts of oxygen as well. Emission and reflection nebula, at the ones we observed, do not have much OIII at all.

*Question: How do images of nebulae change through different telescopes?*

Exploring Field of View, and filters

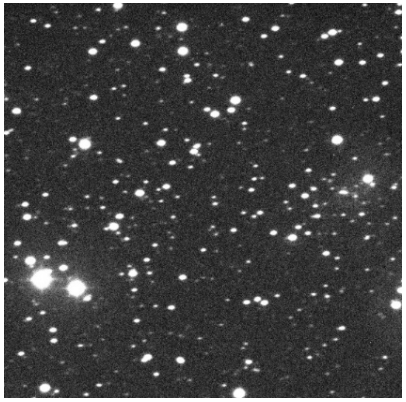
*Chuck, Bonnie, Lynne*

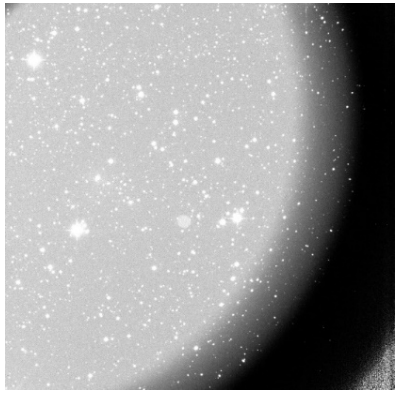
# Procedure

- Pick a nebula from the Sharpless Catalog:
- https://en.wikipedia.org/wiki/Sharpless_catalog
- Collect Image through multiple telescopes, with different filters.
- Exposure time on all images will be 30 seconds.
- Search for other images of nebula in Group Images, or Collaboration Images.
- Use Afterglow program or other image processing program to measure the diameter of the object and horizontal field of view
- Create a ratio between the two for each telescope.

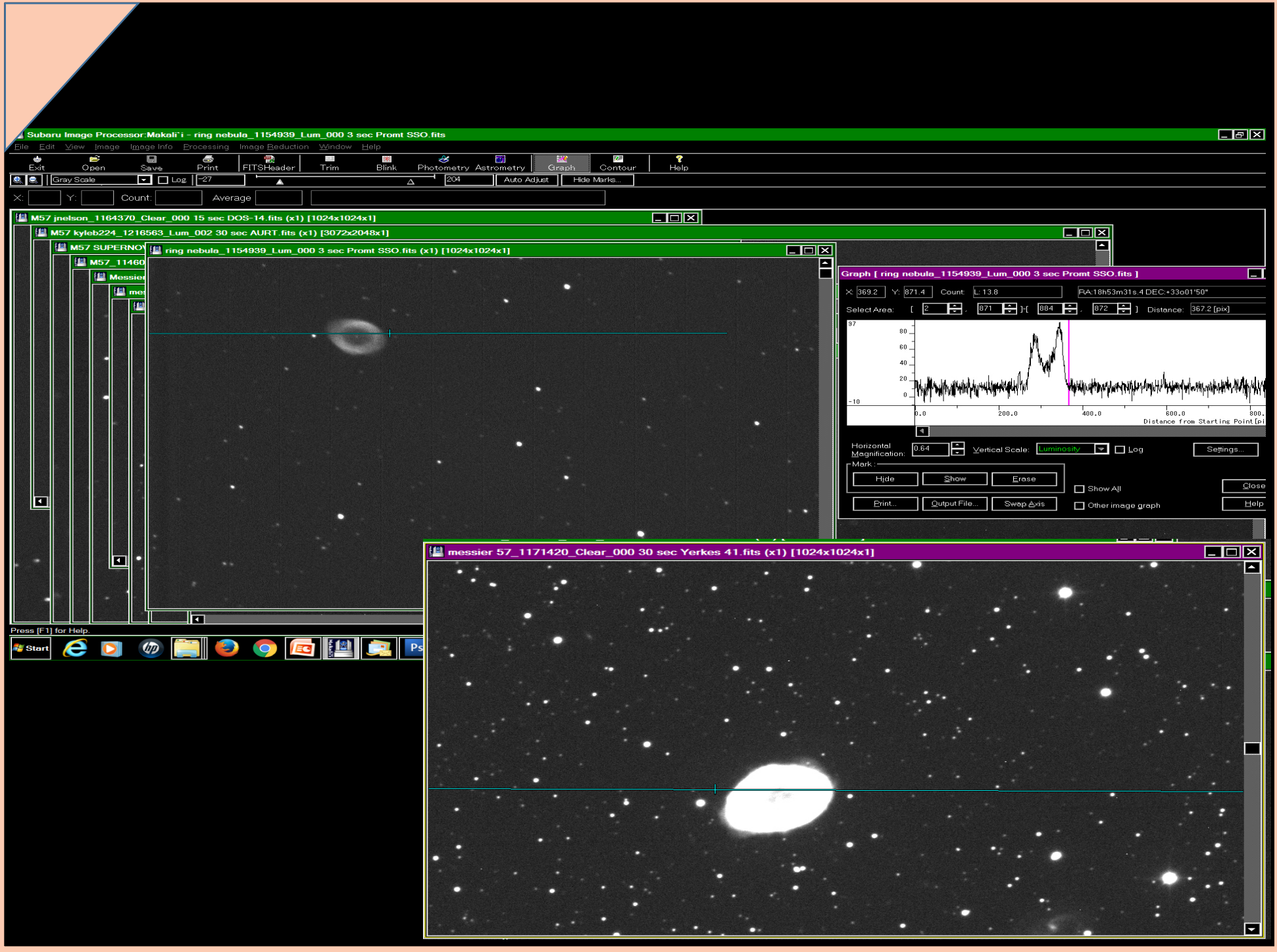
objects selected:
Bonnie: Orion Nebula
Lynne: Ring Nebula
Chuck SH-2

Chuck: Sh2 – 271 Flame Nebula





| | Yerkes 41 | Prompt 1 | Prompt-SSO | DSO-14 | Etc. | R-COP | | |
|---|---|---|---|---|---|---|---|---|
| Ring Nebula | ratio | ratio | ratio | | | | | |
| Sh2-271 Flame | 27.6/ 1011.5 (0.027) | 29.7/ 1007.8 (0.029) | | | | 62.3/ 2167.6 (0.028) | | |
| | | | | | | | | |
| | | | | | | | | |


Subaru Image Processor:Makali'i - ring nebula_1154939_Lum_000 3 sec Promt SSO.fits
File Edit View Image Image Info Processing Image Reduction Window Help
Exit Open Save Print FITSHeader Trim Blink Photometry Astrometry Graph Contour Help
Gray Scale Log Auto Adjust Hide Marks...
M57 jnelson_1164370_Clear_000 15 sec DOS-14.fits (x1) [1024x1024x1]
M57 kyleb224_1216563_Lum_002 30 sec AURT.fits (x1) [3072x2048x1]
ring nebula_1154939_Lum_000 3 sec Promt SSO.fits (x1) [1024x1024x1]
Graph [ ring nebula_1154939_Lum_000 3 sec Promt SSO.fits ]
Select Area: Distance: 367.2 [pix]
Distance from Starting Point [pi
Horizontal Magnification: 0.64 Vertical Scale: Luminosity Log Settings...
Mark : Hide Show Erase
Print... Output File... Swap Axis
Show All
Other image graph
Close
Help
Press [F1] for Help.
Start
messier 57_1171420_Clear_000 30 sec Yerkes 41.fits (x1) [1024x1024x1]

| Telescope | AURT | DSC -14 | DSO-17 | GORT | Promt SSO | Yerkes 41 |
|---|---|---|---|---|---|---|
| Filter | Clear | Clear (Hthru) | | Green | Clear (Lum) | Clear |
| Exposure | 30 | 3 | | 80 | 3 | 30 |
| Ring | 81 | 270 | | 420 | 467 | 662 |
| Full imate | 1526 | 883 | | 1020 | 884 | 1021 |
| Ratio | .057 | .305 | | .510 | .198 | .154 |
| | 5 | 2 | | 1 | 3 | 4 |

# If we had more time….

Combine 3 fits images from each scope to get a more precise view.