

ANCHORAGE MUSEUM

STARS: INTERDISCIPLINARY EXPLORATION UNIT 5. ASTROPHOTOGRAPHY

BACKGROUND INFORMATION

Astrophotographers use filters to photograph different wavelengths of light emitting from their celestial subjects. Astronomers use these photographs to learn more about celestial bodies. Studying these objects with different filters allows astronomers to observe details that would not otherwise be visible to humans. In this unit, you will look at, take, and process astrophotography images.

STUDENTS WILL:

- Learn about astrophotography
- Analyze astrophotography images
- Take and process astrophotography images using NASA's MicroObservatory Robotic Telescope

MATERIALS

- Computer or tablet with internet connection
- Astrophotography Challenge Activity Sheet

RECOMMENDED GRADE LEVEL

- Sixth through eighth grade

KEY TERM

Astrophotography: the use of ground-based or orbital telescopes to photograph celestial bodies, such as planets, stars, comets, and galaxies

ACTIVITIES

This lesson provides three activity sets and explains each of them in detail on the following pages. Activities should be completed in order. Challenge questions are listed under each activity. You can also print the Challenge Activity Sheet, which follows the MicroObservatory Appendix.

1. **Activity 1:** Composite Photographs
2. **Activity 2:** MicroObservatory Robotic Telescope Network
3. **Activity 3:** Astronomy Photographer of the Year



ACTIVITY 1

Composite Photographs

[5 minutes]

Astrophotographers and astronomers take multiple pictures of the same celestial body using different filters. They edit these pictures together to create composite images to show multiple wavebands of light. Each waveband is assigned a different color in the image.

View this image of Cassiopeia A, a supernova remnant, at this website:
<https://astropix.ipac.caltech.edu/image/spitzer/ssc2005-14c1>

Challenge Questions:

1. What wavebands of light are combined in this Cassiopeia A image?
2. What color is each waveband assigned in the image?

ACTIVITY 2

MicroObservatory Robotic Telescope Network

[Two sessions: 30 minutes to request images; 30-60 minutes to process images]

Through the Observing With NASA portal, the MicroObservatory Robotic Telescope Network allows users to control ground-based telescopes remotely, take images of celestial objects, and edit these images in a variety of ways. Using only a computer and internet, you can be an astrophotographer.

The MicroObservatory website has many resources to help you take and edit photos. Feel free to explore the website on your own. Here is a suggested sequence of how to navigate the website with challenge questions.

UNDERSTAND HOW MICROOBSERVATORY WORKS

Website: <https://mo-www.cfa.harvard.edu/OWN/about.html>

Challenge Questions:

1. How tall are the MicroObservatory telescopes?
2. What states are some of the MicroObservatory telescopes located in?
3. How long will it take to get your requested image back?

ACTIVITY 2 CONTINUED

CONTROL A TELESCOPE TO REQUEST YOUR OWN IMAGES

Website: <https://mo-www.cfa.harvard.edu/cgi-bin/OWN/Own.pl>

Watch the 'How to Request an Image' tutorial video:

https://www.youtube.com/watch?v=hxioUmssb1o&list=PL2TJ0Y_PLXCyc9dI-JNKsXaubOwxoboFvq&index=1

Challenge Questions:

4. Find at least one target that allows you to select 'multiple filters' when you adjust your telescope settings. This will give you more processing options.

Repeat this process for as many targets you would like to photograph. It may take a few days to get your photographs in your email.

Refer to **MicroObservatory Appendix** at the end of this lesson to help you remember the steps to control a telescope and process an image.

PROCESS YOUR OWN IMAGES

Website: <https://waps.cfa.harvard.edu/eduportal/js9/software.php>

Watch the 'How to Open a FITS Image' tutorial video:

https://www.youtube.com/watch?v=linKgUN1inw&feature=youtu.be&list=PL2TJ0Y_PLXCyc9dIJKSxaubOwxoboFvq

Watch the 'How to Process a FITS Image' tutorial video:

https://www.youtube.com/watch?v=0OTPQ4mR9Fk&feature=youtu.be&list=PL2TJ0Y_PLXCyc9dIJKSxaubOwxoboFvq



ACTIVITY 2 CONTINUED

Below are links to other helpful video tutorials:

- How to Create a Simple RGB Image:
https://www.youtube.com/watch?v=RhR0oSfo10w&list=PL2TJ0Y_PLXCyc-9dIJNKSxaubOwxoboFvq&index=4
- How to Create an Advanced RGB Image:
https://www.youtube.com/watch?v=VwEJTDoHAgQ&list=PL2TJ0Y_PLXCyc-9dIJNKSxaubOwxoboFvq&index=5
- How to Blend Multiple Images:
https://www.youtube.com/watch?v=2WY7B1fcXR&list=PL2TJ0Y_PLXCyc-9dIJNKSxaubOwxoboFvq&index=6
- How to Combine Images for a Longer Exposure:
https://www.youtube.com/watch?v=O1p6h6P23Js&list=PL2TJ0Y_PLXCyc-9dIJNKSxaubOwxoboFvq&index=7
- How to Animate Images:
https://www.youtube.com/watch?v=Asg5OIC36N0&list=PL2TJ0Y_PLXCyc-9dIJNKSxaubOwxoboFvq&index=8

All MicroObservatory Tools & Training Resources are found at the following website: <https://mo-www.cfa.harvard.edu/OWN/training.html>

Challenge Questions:

5. Create a true color image, also known as a simple RGB image, by blending the red, blue, and green images for the same target. The red, blue, and green images are generated by selecting 'multiple filters' when you adjust your telescope settings.

Refer to **MicroObservatory Appendix** at the end of this lesson to help you remember the steps to control a telescope and process an image.

ACTIVITY 3

Astronomy Photographer of the Year

[15 minutes]

Explore some of the world's most recognized astrophotography taken from ground-based cameras and telescopes. The international Insight Investment Astronomy Photographer of the Year competition receives photography submissions in several categories ranging from galaxies, our sun, and skylscapes. Winning entries are displayed at a Royal Museums Greenwich institution.

Learn more about the competition at this website: <https://www.rmg.co.uk/whats-on/astronomy-photographer-year/competition#about>

View the 2019 Stars and Nebulae category winners at this website: <https://www.rmg.co.uk/whats-on/astronomy-photographer-year/galleries/2019/stars-and-nebulae>

Challenge Questions:

1. Which image has the longest exposure time?
2. Why would a photographer want a longer exposure time?

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MICROOBSERVATORY APPENDIX

The MicroObservatory Robotic Telescope Network allows users to control ground-based telescopes remotely, take images of celestial objects, and edit these images in a variety of ways. Using only a computer and internet, you can be an astrophotographer.

CONTROL A TELESCOPE TO REQUEST YOUR OWN IMAGES

1. Go to website <https://mo-www.cfa.harvard.edu/cgi-bin/OWN/Own.pl>
2. Select Target
 - Click 'Observe' for a target you want to photograph
3. Adjust Your Telescope Settings

Field of view – The area being photographed

 - 1 degree – if you extend your arm in front of you, your pinky nail covers this size area of sky
 - .5 degree – ½ pinky nail
 - 10 degrees - fist

Exposure Time – How long telescope shutter is open which influences how much light is captured

 - For objects far away (outside our solar system), you want long exposure time

Filter selection

 - Select 'multiple' if you are able; this will give you more processing options
4. Click 'Continue' and enter requested information

PROCESS YOUR OWN IMAGES

1. Save all images emailed to you from MicroObservatory as high-quality FITS images
2. Open all images you want to process with the JS9-4L web-based processor, found at this website: <https://waps.cfa.harvard.edu/eduportal/js9/software.php>
3. Select one image to process first
4. Adjust scale: Log
5. Adjust brightness limits (read pixel values for darkest and brightest spots)
6. Image: display FITS Header, read filter type
7. Color: select appropriate color (red, green, or blue)
8. Repeat steps 4-7 for each image
9. Combine red, blue, green images:
 - Color: RGB Mode

OR

 - Tools, Blending, select all images you want blended, setting should be screen & opaque, check the 'image blending' box at top
10. Line up images: Tools, Shift, observe which image you are shifting
11. Zoom: Tools, Magnifier
12. Save: Image, Save as JPEG



ASTROPHOTOGRAPHY CHALLENGE ACTIVITY SHEET

ACTIVITY 1. Composite Photographs

1. What wavebands of light are combined in this Cassiopeia A image?
2. What color is each waveband assigned in the image?

ACTIVITY 2. MicroObservatory Robotic Telescope Network

1. How tall are the MicroObservatory telescopes?
2. What states are some of the MicroObservatory telescopes located in?
3. How long will it take to get your requested image back?
4. Find at least one target that allows you to select 'multiple filters' when you adjust your telescope settings. This will give you more processing options.
Repeat this process for as many targets you would like to photograph. It may take a few days to get your photographs in your email.
5. Create a true color image, also known as a simple RGB image, by blending the red, blue, and green images for the same target. The red, blue, and green images are generated by selecting 'multiple filters' when you adjust your telescope settings.

ACTIVITY 3. Astronomy Photographer of the Year

1. Which image has the longest exposure time?
2. Why would a photographer want a longer exposure time?



ASTROPHOTOGRAPHY ANSWERS SHEET

ACTIVITY 1. Composite Photographs

1. Infrared; Visible; X-ray
2. Infrared - colored red; Visible – colored yellow; X-ray – colored green and blue

ACTIVITY 2. NASA's MicroObservatory Robotic Telescope Network

1. 3 feet
2. Massachusetts (MA) and Arizona (AZ)
3. Within 24-48 hours
4. You are successful if you get multiple images back for the same target. Each image will have been taken with a different filter.
5. You are successful if you create one image that blends red, blue, and green images for the same target. If you are stuck, watch this tutorial video: https://www.youtube.com/watch?v=RhR0oSfo10w&list=PL2TJ0Y_PLXCyc9dIJNKsXaubOwxoboFvq&index=4

ACTIVITY 3. Astronomy Photographer of the Year

1. *Deep in the Heart of Mordor - NGC 7293* by Andrew Campbell has an exposure time of 63 hours, 58 minutes. This is a photograph of the Helix Nebula (also called NGC 7293).
2. Longer exposure times means the camera shutter is open for longer amounts of time, letting greater amounts of light to be captured. For distant objects (including the Helix Nebula which is approximately 655 light years away from Earth), long exposure times are needed to capture any light.

