

**Origin:** The “Kids Capture Their Universe” (KCU) out-of-school time program was developed by the education and outreach group at the MIT Kavli Institute for Astrophysics and Space Research (MKI) and the Science Education Department at the Smithsonian Astrophysical Observatory (SAO) during 2006 and 2007, in partnership with Citizen Schools, Boston. Final pilot testing was completed in Boston during spring 2008. By May 2009, the KCU program had been run 13 times in 9 locations, engaging about 80 youth, with youth presenting to hundreds of community members, parents and other students. The initial funding for KCU was provided through the Education and Public Outreach program of NASA’s Chandra X-Ray Observatory.

**Activities:** KCU grew out of a desire to share authentic aspects of being an astronomer and astronomy educator with young people. Following the Citizen Schools approach (<http://www.citizenschools.org/whatwedo/ourmodel/apprenticeships.cfm>), KCU is designed as an apprenticeship where adults share their expertise and passion by helping youth to create a product, performance, or presentation produced by the students and taught back to the community. In KCU, the product is a live astrophotography exhibit.

The KCU apprenticeship is designed for 90-minute sessions once per week for 11 weeks, where hands-on learning projects emphasize the broad set of skills necessary for success in the modern economy: leadership, teamwork, oral communication and technology. In KCU, youth learn to request astronomical images from the MicroObservatory robotic telescope network and use image-processing software to reveal and emphasize important details about their images, just as professional astronomers do. They work in small groups to organize and present an astrophotography exhibit made of several “stations,” each complete with images, written captions, 3D models, and creative poems reflecting the science content they learn. In addition, youth teach the audience to use software to explore and personalize their own images of the universe.

**Outcomes:** The KCU activities give youth an opportunity to develop the following focused skills, identified by Citizen Schools as “New Basic Skills”:

Teamwork: Youth are able to contribute to group work while sharing the “spotlight.”

Leadership: Youth are able to speak more confidently in front of an audience.

Advanced Literacy: Youth are able to correctly apply terms and vocabulary associated with the KCU program.

**Implementation:** The apprenticeship approach followed in KCU can be implemented by a variety of out-of-school-time (OST) organizations to support their missions to promote science and technology learning. It is also an effective way to engage space science professionals, amateurs and graduate/undergraduate students (called “astronomy volunteers”) in a satisfying and productive outreach experience.

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# Kids Capture Their Universe: An Astronomy Out-of-School Program

## Overview of the Program

**Program Advertisement:** The Facilitators introduce potential youth to the program through interactive demonstrations of program experiences (image processing and/or astro-creative activities) and/or showcases of program topics (telescopes, astrophotography and/or exhibitions)

**Weeks 1-5:** The first half of the program is spent learning the “tools of the trade” and developing teamwork and presentation skills. Each week consists of three key components, in addition to the opening and closing circles:

- Icebreaker/Team-Building Activity

Part of the opening circle, each week includes a non-astronomy activity that helps the group get to know each other better and foster a fun, supportive environment.

- Image Requests and Processing

In addition to learning how to use the MicroObservatory telescopes to request images of astronomical objects, youth gain familiarity with basic image processing techniques for astronomical images. Explorations consist of a guided activity (in which the facilitator models the use of one or more processing tools), a challenge (in which youth re-create a pre-processed image using those tools), and free processing (in which youth apply these tools to the images they have requested). Youth also create descriptive captions to accompany each processed image and practice sharing and reflecting on these images with their fellow youth and facilitators.

- Astro-Creative

Youth devote time each week to a hands-on project that draws upon and showcases their creative talents: kinesthetic modeling, poetry, and art/sculpture

- Week 5 is traditionally devoted to a field trip, during which youth can talk to experts, share and ask questions about their images, see real telescopes, and/or visit a professional museum exhibition.

The knowledge, skills, and products developed during Weeks 1-5 will be incorporated into the final exhibition and/or used as an example for creating the displays and presentations.

**Weeks 6-10:** The second half of the program is spent assembling the final astrophotography exhibit displays and presentations, using the skills and products developed during the first half of the program. Youth practice presenting and demonstrating their projects and skills.

**Astrophotography exhibit:** The final exhibition is presented to the community. Be sure to start planning this before the program begins so you can communicate clear expectations to the youth!

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### **Products needed for the Astrophotography exhibit:**

Each group of youth should create:

1. A portable exhibit display, mounted on poster board/foam core or other display structure that can be set up on a table or easel. Each display must contain:
  - Quality images of several objects, taken with MicroObservatory and processed by the youth using the MicroObservatoryImage software
  - Youth-written captions for each image in the display
  - Individual and/or group-made poem and/or 3D model that adds to the understanding of the theme of that part of the exhibition
  - Title and descriptive summary of the display
  
2. A well-rehearsed oral presentation, featuring one or more elements of the exhibit display above and presenting information about astronomy and/or the program to visitors in a creative way. Presentation topics could include:
  - Explanation/guided tour of the exhibition
  - Explanation/demonstration of image processing, focusing on one or more specific tools and/or images presented in the display
  - What happened during the program
  - An explanation of how telescopes work and what they do, using images, sketches and/or a real telescope
  - Information about a class/category of objects, as demonstrated with their own images
  - A comparison of MicroObservatory images with professional astronomy images
  - Demonstration/explanation of a kinesthetic model
  - Interactive demonstration of physical model building or sculpture based on one or more images.
  - Interactive demonstration of poem making, based on one or more images.

All displays should be arranged into a creative exhibition with approximately 15' x 15' floor space. Presentations may be given as part of the exhibition or in an auditorium.

### **Physical supplies needed for the program** (quantities reflect 8-12 youth)

- 20 pens/pencils, 20 markers, 150 blank note cards, hanging file folders (one per youth), sticky notes, ~100 colored dot stickers, name tags, 5 glue sticks, masking tape, Scotch tape & dispenser, dry erase markers/eraser, 3-4 scissors, stapler, small box of clay, 4-5 blindfolds, prizes (e.g. candy, trinkets), large chart paper (for wall) and craft supplies, as described in Week 4 (page 48)

### Technical Requirements for Running the Program

#### *Ideal requirements:*

- Computer area/room with one (1) computer per youth (PC or Mac OK)
- Every computer has internet connection with access to <http://www.MicroObservatory.org>
- Every computer has free access to read and write to a USB memory key.
- One USB memory key for each computer. Materials on key include the following:
  - Free MicroObservatory Image processing software: <http://mo-www.harvard.edu/MicroObservatoryImage/> (Can be run from the key.)
  - Folders for incoming requested images and youth processed images.
- Access to color printer for final exhibit images
- Access to black and white printer/copier
- Access to computer specialist to help (on minimal “as needed” basis) with the following:
  - Initial software installation / setup
  - Change computer display properties
  - Clarify procedures for use of computers
  - Resolve technical problems
- Activities area: 10-12 people able to stand in an open circle
- Secure, accessible storage space for materials (approximately 2 hanging file folder boxes)

#### *Acceptable alternatives to ideal setup above:*

- One computer per **pair** of youth
- Only 1 to 2 computers with Internet connection: Youth will have to share when requesting images.
- As an alternative to USB memory keys, each computer must have the following:
  - Free MicroObservatory image processing software (<http://mo-www.harvard.edu/MicroObservatoryImage/>) downloaded, installed, and running.
  - Ability to save files to a location easily accessed by the facilitator and youth.
  - Stability of computer such that software installation / saved files, etc. are not erased or moved from week to week.
  - Ability to transfer files between computers (local network or flash drive or disk drive with read/write access, etc.), so facilitator can collect/distribute image files.

## **Computer File Management Guide**

After youth request images, the following 4 file management steps must be taken before the image is ready for the exhibit.

### **1. Retrieve FITS images from MicroObservatory**

BY EMAIL: When an image is requested via the MicroObservatory Guest Observer Portal, the telescope will take the image that night and send an email to the user's email address, assuming it was entered correctly. The easiest way to access the image is to check the email account and **click on the link** provided in the email.

*The email will come from [MicroObservatorySupport@cfa.harvard.edu](mailto:MicroObservatorySupport@cfa.harvard.edu) Users may wish to set up a filter in the mail program so that all emails from this address go to the same folder.*

Due to security constraints on public computers, however, youth may not be able to check their email on the school computers. The best way to deal with this issue is for a facilitator to **pre-load the youth's USB memory keys or computers** each week with the images requested the previous week. We recommend having all image requests by youth sent to an independent email address created and monitored by the facilitator, using a service like Google Mail.

BY WEB: If retrieving images via email is not possible, the images can be accessed via the web, at either of these two locations:

- The daily index of the Guest Observer Portal images:  
<http://mo-www.harvard.edu/GA/ImageAnalysis/TodaysImagesMM:DD:YYYY>  
(fill in the month, day, and year for the day AFTER the images were requested)
- Main MicroObservatory Image Directory:  
<http://mo-www.harvard.edu/jsp/servlet/MO.ID.ImageDirectory>  
(look for users "moguest" and "cquestions" on the correct date)

### ***Be sure to retrieve and transfer the unprocessed FITS files, not the GIF thumbnails!***

Note that links above include MORE images than those requested by the youth. If this is the intended method of retrieval, it may be useful for the facilitator to make note of the images requested by youth so that only those images get downloaded and transferred to the youth's USB memory keys or computers.

### **2. Transfer FITS images to USB memory keys or computers**

Once the images requested by youth are gathered, they must be made available to youth for processing. Do this before the session begins. It is the facilitator's responsibility to make sure youth have the images they need for each session. Some options:

1. Load all requested images onto USB memory keys for access by youth. Easiest option is to put all new requested images onto every key, so youth can access all.

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2. Upload all requested images to a central server and download them to each machine. (Make sure there is a valid Internet connection on each machine.)
3. Some combination of the above (e.g. upload images to a server, download them to one computer and transfer them to others via flash drive.)

Unprocessed FITS images should be stored on identical folders on each USB memory key or computer, so that all youth can follow a single procedure for retrieving them. We suggest weekly request folders within a larger “Images” folder.

### 3. Youth save processed GIF images

Choose a system that works for you and be consistent. Once an image is processed by youth, they should save it into a location accessible to the facilitator. Some options:

1. A collective “Processed Images” folder (if youth do not use a consistent USB memory key or computer each week)
2. A personal “Name’s Processed Images” folder (if youth use the same USB memory key or computer each week)

Youth will need to **specify the folder** when they click “Save As...” because the default is the same folder from which the original FITS image was retrieved.

If you are NOT using USB memory keys: Before the program begins, **make sure that images (and the image processing software) will remain on the computers from week to week.** Double-check this during Weeks 1 & 2! If the machines are cleared each time the youth logs out, you will need to reinstall both the software and the images each week, including the original FITS files and the youth’s processed GIF images.

### 4. Facilitator retrieves youths’ processed GIF images for storage or printing

Two options:

1. Collect all USB memory keys or other portable media storage device
2. Upload images to a central server to download and print later

It is expected that **facilitators will be responsible for printing** the final color images for the youths’ exhibits.

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YOUR GOAL is to find a system that works well at your site. Astronomy volunteers should work with out-of-school time staff to make sure youth can find and save their images appropriately.

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### **Facilitating New Basic Skills**

There are several ways in which to support the development of these skills, which are built into the KCU curriculum.

*Working with vocabulary:* Each week, there are 4-5 “focus vocabulary” words. These words and their definitions should be printed out, possibly laminated, and posted prominently in the room before the start of each session. (See Appendix B.) Additional vocabulary that come up in each lesson can be presented, but maintain specific effort on using the focus vocabulary. Other ideas include the following:

- Presenting vocabulary at start of lesson: Several approaches include a physical scavenger hunt to locate the printed definitions scattered around the room, assigned youth read vocabulary out loud, or the facilitator reads vocabulary out loud. The introduction of vocabulary should be very short, but then incorporated throughout the lesson.
- Caption writing: This is the most important way youth can learn vocabulary and content. Award points for correctly using vocabulary in written captions, with team or individual points across one day leading to recognition/ award.
- Vocabulary “jeopardy”: Although a version of this is included explicitly in week 8, at any time youth can be challenged to recall a vocabulary word based on its definition, or an image that shows or demonstrates it. (e.g. “What kind of object is in this image?” A planet! or “Which tool was used in processing this image?” Zoom!)
- At closing circle: Based on their experience that session, have youth define or give an example of one of the vocabulary in their own words.

*Supporting teamwork:* In addition to the “Lighthouse game” in week 7 and the group selection of exhibit materials and exhibit groupings, other ideas include the following:

- Image processing: After week 1, youth can be paired during “free processing time” and develop processing challenges for their partner (i.e. can you make your image look like mine?)
- Caption writing: Paired youth can write captions for their partner’s image, forcing them to interview their partner for information.
- Closing circle: Youth can give recognition to good work done by peers, including recognizing good image / caption combinations on the image wall (see next section)
- Image wall: Based on initial caption/image combinations on the wall, youth can add more comments/ questions to each caption, leading to a richer discussion, and “group-created” captions.

*Speaking confidently in front of an audience:* In addition to the presentation demonstration and games in weeks 9 and 10, other ideas include the following:

- Caption writing: With any additional time, youth read captions aloud to partners or the group.
- Introducing vocabulary: Youth read vocabulary aloud to partners or the group.
- Closing circle: Read captions or give verbal recognition to the work of others.

### **Creating an Image Wall on Ongoing KCU Program astrophotography exhibit board**

During pilot runs of this program, pilot facilitators expressed a need for weekly physical recognition of the youth's work:

**A physical or electronic display of youth's color images, accompanied by information about them (process to create, contents, inspiration, etc.), contributed by the creator and/or peers**

There are many reasons for doing this:

- Actually seeing printed/publicly displayed images provides concrete sense of accomplishment and progress toward the final exhibit
- Encourages teamwork and cooperation (a New Basic Skill)
  - Youth can help write captions for other people's display-worthy images
  - Youth can work together to create a caption that compares two views of the same object, or that relates an image to a poem
- Rewards youth for good work (both image processing and caption writing)
  - Only images with good captions or interpretation get displayed
  - Facilitator can nominate images/captions to the board
  - Youth can give "shout outs" to their peer
- Encourages/motivates youth to create display-worthy images and captions
- Reduces the amount of work required during the final weeks of the program
  - Bulk of images are pre-chosen
  - Youth need only to reorganize
  - Captions can be edited rather than re-created
  - Provides a model of what an exhibit display board should look like
- Provides a public display for group-created AstroCreative projects (i.e. poems, photos of sculptures) that may not make it into youth's own exhibit displays

#### **What form should this take?**

Best option: Print out the best images and captions each week and add them to an exhibit display board that is updated weekly.

- *Pro: provides a physical place where youth can watch the exhibit develop*
- *Con: Requires weekly access to a color printer*

Backup option: Create a digital display of the electronic images that gets updated each week (e.g. Flickr or other online photo album program, PowerPoint or "Best Of" folder on the facilitator's "master computer")

- *Pro: Does not require weekly access to a color printer*
- *Con: Does not have a concrete connection to the physical display*

If an electronic photo album is created, the facilitator can print out the chosen images when it is time to assemble the final exhibition. Either way, the resulting exhibit board that the group creates will become an introductory panel in the final exhibition and model for the youth what the boards should look like.

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### How should the board/album be organized?

Images and accompanying captions can be posted with no particular organization in mind, or the facilitator can provide some overarching guidance. We recommend:

- Divide the board into five sections, one for each week
- Divide the board into categories that relate to specific program content
  - Processing tools/activities (changing contrast, astro-poetry, etc.)
  - Astronomical objects (Moon, planets, stars, nebulae, galaxies)
- Other, at the facilitators' and youth's discretion

Although black-and-white placeholder images can be used, most of the youth's excitement comes from seeing the full color versions of their images.

### When should images and accompanying information be added?

Option 1: Youth and facilitators nominate and select images for the board during the processing challenge reflection period. A facilitator prints those images and captions out while other activities are going on, and adds them to the board during closing circle.

Option 2: Youth and facilitators nominate and select images for the board during the reflection time and/or closing circle. A facilitator prints them out during the week and adds them to the board at the following week's opening circle.

Option 3: A facilitator prints out all "display-worthy" images and captions during the week and youth choose which ones to display during opening circle the following week.

**It is up to the facilitators how and when this display will be created. The main goal is for youth to see throughout the program how their work is becoming a part of a real exhibition.**

Template for activity write-up appears on Page 12 of this curriculum. Be sure to add this activity to each week's lesson plan!

## Weekly Lesson Plans

### KCU Program Advertisement

- Strategies for Engaging Youth

### Week 1: Introduction to Telescopes and Images

- Look Through a Telescope/Kinesthetic Telescope
- Processing Challenge: The Prudential Tower

### Week 2: The Moon, Planets, and Our Solar System

- Processing Challenge: The Moon (sharpen, zoom, crop)
- Astro-Creative Challenge: Astro-Poetry

### Week 3: Stars and Nebulae in our Milky Way galaxy

- Processing Challenge: Orion Nebula, Hercules Star Cluster
- Astro-Creative Challenge: Kinesthetic Life Cycle of Stars

### Week 4: Galaxies Outside the Milky Way

- Processing Challenge: Whirlpool Galaxy
- Astro-Creative Challenge: Astro-Sculpture

### Week 5: Field Trip

### Week 6: Prepare Exhibit Materials

- Image Processing and Selection
- Final Image Caption Writing

### Week 7: Exhibit Component Construction

- Group Selection and Planning
- Creative Component Construction
- Final Resources Assembled

### Week 8: Final Exhibit Construction

- Exhibit Displays Assembled
- Introduction to Visitor Conversations

### Week 9: Prepare and Practice Presentations

- Prepare Presentations and Demonstrations
- Practice Presenting and Provide Feedback

### Week 10: Final Preparation for astrophotography exhibit

### Week 11: Optional Reflection

### Supplemental Activities: Making Images, Images from Telescopes, False Color Tables



**Week 1 (With Telescope)**

**Lesson Objectives: *What do we need to get done today?***

**By the end of the lesson, the youth will:**

1. Get to know each other and the Facilitator
2. Take at least one image of a Moon or planet with MicroObservatory telescope

**Learning Objectives: *What will the youth learn today?***

**By the end of the lesson, the youth will have learned:**

1. How a telescope works
2. How to take images with the MicroObservatory telescopes
3. How to open and save images with the image processing software

**Agenda based on the lesson plan. Post in the room for the youth to see.**

- |   |            |
|---|------------|
| 1. Opening: Survey & Get To Know You Icebreaker | 15 Minutes |
| 2. Review Agenda and exhibit format             | 5 Minutes  |
| 3. Activity: Looking Through a Telescope        | 15 Minutes |
| 4. BREAK  | 5 Minutes  |
| 5. Take Images: Moon, Planets                   | 10 Minutes |
| 6. Activity: Introduction to Image Information  | 10 Minutes |
| 7. Processing Challenge: Prudential Tower       | 20 Minutes |
| 8. Closing Circle                               | 10 Minutes |

**Preparation and Space Set up:**

Post daily agenda, 10-week program outline, and focus vocabulary for youth  
 Make sure software is installed and running on the computers  
 Load challenge images into appropriate folder on the computer  
 Create youth's processed images folder on each machine  
 Set up telescope

**Vocabulary** *What terms or concepts will you introduce in this session? Post these for the youth to see.*

Focus Vocabulary (to be posted): Telescope, image, pixel, brightness, image processing  
 Additional Vocabulary (to be aware of): Exposure time, aperture, mirror, shutter, detector

**Materials and Equipment**

*Physical resources:* Survey, writing utensils, observing logs, empty portfolio folders, vocabulary

*Electronic resources:* Stock challenge image (TowerChallenge.FITS)

*Computing resources:* Image processing software, Internet browser, folders set up on computer

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Week 1 Icebreaker: A Big Wind Blows		Time: 10 minutes
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY (1 minute)</p> <ul style="list-style-type: none"> <li>All youth stand in a circle with the facilitator in the center. Use chairs or desks to mark each youth’s place in the circle.</li> <li>The person in the middle says. “My name is [name] and I [something that is true about me]. (E.g. am wearing sneakers, have brown hair)</li> <li>Everyone else for whom that fact is also true (e.g. everyone who is wearing sneakers or has brown hair) leaves their spot and tries to find a new spot. The person in the middle takes someone else’s spot.</li> <li>The person who is left without a spot is in the middle</li> </ul> <p>DO THE ACTIVITY</p> <ul style="list-style-type: none"> <li>Repeat the process above, being sure to include facts that cannot be seen just by looking at people (e.g. “is an only child,” “used to live in another state,” “likes basketball”)</li> </ul> <p>DISCUSS THE ACTIVITY</p> <ul style="list-style-type: none"> <li>Astronomers make observations of objects in space, using telescopes and other tools.</li> <li>Some properties of an object can be observed just by looking at them (shape, brightness, etc.). Others need more information to explain what they are like (what they are made of, how they move, etc.)</li> <li>In this program, we will be making observations of objects in space and learning more about them through activities and research.</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To get to know each other</p> <p>To begin thinking about how to describe objects</p>	

<b>Week 1 Activity:</b> Looking Through a Telescope		<b>Time:</b> 15 minutes				
<p><b>Procedure</b></p> <p>PREPARE THE ACTIVITY</p> <ul style="list-style-type: none"> <li>Set up a telescope outside, if possible, or in a long hallway or classroom. Point the telescope at the Moon or an object on Earth that is far enough away that its details cannot be resolved.</li> </ul> <p>DO THE ACTIVITY</p> <ul style="list-style-type: none"> <li>Hand out paper to each youth and instruct them to split it into three sections—two large sections next to each other at the top, and one smaller section at the bottom (see example, right)</li> <li>In one section, youth sketch the object as it appears to them standing next to the telescope</li> <li>In the second section, youth sketch the object as it appears to them looking through the telescope</li> <li>In the third section, youth write a caption explaining what they expected to see, what they saw, and how the two views compare</li> </ul> <p>DISCUSSION</p> <ul style="list-style-type: none"> <li>What do telescopes do? (They show us more detail in objects that are far away)</li> <li>Youth can share their captions if desired</li> </ul>		<p><b>Objective</b></p> <p>To look through a telescope</p> <p>To compare naked eye views with telescopic views</p> <p>Example of observation page:</p> <table border="1"> <tr> <td>Section 1 (view without telescope)</td> <td>Section 2 (view with a telescope)</td> </tr> <tr> <td colspan="2">Section 3 (caption explaining expectations and observations)</td> </tr> </table>	Section 1 (view without telescope)	Section 2 (view with a telescope)	Section 3 (caption explaining expectations and observations)	
Section 1 (view without telescope)	Section 2 (view with a telescope)					
Section 3 (caption explaining expectations and observations)						

**Materials Needed:** Telescope, paper, pens/pencils

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<b>Week 1: Request images from MicroObservatory</b>		<b>Time: 10 minutes</b>
<ul style="list-style-type: none"><li>Week 1: facilitator models how to request an image using the Guest Observer Portal and record the request in the Observation Log</li></ul> <p>HOW TO REQUEST AN IMAGE</p> <ul style="list-style-type: none"><li>Open Internet browser</li><li>Go to <a href="http://www.microobservatory.org">www.microobservatory.org</a></li><li>Choose an activity (see list below)</li><li>Choose an object</li><li>Choose an exposure time (faint objects require longer exposure times)</li><li>Enter an email address (easy option is to use account created and monitored by facilitator, see page 6)</li><li>Record request in observing log</li><li>Confirm request</li></ul>	<p><b>Objective</b></p> <p>Take images of the Moon and planets for next time.</p>	

**Hint:** It will save you time if you write the URL on the board for youth to see (it is also written on their observing logs)

**Note:** The automated emails from the MicroObservatory server are sent around 1 p.m. the day AFTER images are requested.

### Where will youth find the various telescope targets they need?

Look within the following Guest Observer Portal activities to find the desired targets

- **Moon (Telescope As Time Machine, Galileo)**
- **Planets (Galileo, Telescope As Time Machine)**
- Stars & Star Clusters (Galileo, Telescope As Time Machine)
- Nebulae (Colorful Cosmos, Black Hole Hunt)
- Galaxies (Galaxies Galore, Black Hole Hunt)

Week 1 Activity: Introduction to image information      Time: 10 minutes	
<p>INTRODUCTION (Open and Explore the Image)</p> <p>Youth do each action along with the facilitator</p> <ol style="list-style-type: none"> <li>1. Open the image processing software</li> <li>2. Click “File” &gt; “Open image on local disk...” and choose the image from the appropriate folder (TowerChallenge.FITS)</li> <li>3. Click “Window” &gt; “Image Info”</li> <li>4. Move cursor over the image and notice the changes in the Image Info window. Three possible answers. The third being the one to focus on:               <ol style="list-style-type: none"> <li>a. The picture in the view box changes</li> <li>b. The numbers next to “X” and “Y” change</li> <li>c. The number next to the word “Pixel” changes</li> </ol> </li> <li>5. Explain what is going on. Again, answer “c” is the one to focus on.               <ol style="list-style-type: none"> <li>a. The view box allows us to see a closer view of the object</li> <li>b. The numbers next to “X” and “Y” tell us where we are in the image</li> <li>c. The “Pixel Value” number tells how bright that part of the image appears, or how much light is coming from that part of the object</li> </ol> </li> <li>6. CHALLENGE: Where in the image is the pixel value the highest? What value does it have? Where is it lowest?</li> <li>7. OPTIONAL EXPLORATION: How can youth get a better view of the individual pixels? (Answer: zoom tool—the magnifying glass icon at the top of the image)</li> </ol>	<p><b>Objective</b></p> <p>Learn how to open an image on the computer</p> <p>Use the mouse and “Image Info” window to get information about the image.</p> <p>(Optional) Use the zoom tool to see the pixels more closely</p>

<b>Week 1 Processing Challenge:</b> Prudential Tower (Quick reference available on page C-2 of the curriculum)	<b>Time:</b> 20 minutes (including reflection)
<p><b>MODEL THE ACTIVITY</b></p> <p>Youth do each step along with the facilitator to achieve the activity goal: <b>To increase the contrast between the windows on the left side of the building and the building itself.</b></p> <ol style="list-style-type: none"> <li>1. Re-open the image TowerChallenge.FITS or return it to its original view by double clicking on the magnifying glass icon to zoom all the way out</li> <li>2. Make sure the “Image Info” window is open</li> <li>3. Click “Process” &gt; “Adjust Image...”</li> <li>4. Point out the “Max” and “Min” fields in the “Adjust Image” window and explain that changing these numbers changes the appearance of the image.</li> <li>5. Explain that you want to make the windows on the left side of the building appear white against a black background.</li> <li>6. Click on the main image window, and note in the “Image Info” window the approximate pixel value of the area that you want to appear white—windows.</li> <li>7. Enter that value (300) into the “Max” field (be sure to hit enter).</li> <li>8. Click on the main image window, and note in the “Image Info” window the approximate pixel value of the area of the image that you want to appear black—the surrounding building.</li> <li>9. Enter that value (275) into the “Min” field (be sure to hit Enter).</li> <li>10. Click on “File” &gt; “Save Image As...” &gt; “GIF” and choose the folder to save it in (e.g. “Week 1”)</li> <li>11. Save the file with a descriptive file name (e.g. NameTowerDate.GIF)</li> </ol>	<p style="text-align: center;"><b>Objective</b></p> <p>Learn how to change the contrast of an image using the “Adjust Image” tool.</p> <p>(Optional) Learn how to use false color tables to change the appearance of an image</p> <p>Learn how to save images with descriptive file names.</p> <ul style="list-style-type: none"> <li>• Object name</li> <li>• Youth name</li> <li>• Descriptive feature such as date or color of processing</li> <li>• File extension (.GIF) must be added explicitly.</li> </ul> <p><b>Additional Information:</b></p> <p>At the end of this activity, youth should reopen the program and the image to make they can find and access the image on their computer. If a file is not saved as a GIF with a .GIF extension, it will not open!</p> <p><b>Astrophotography exhibit Goal:</b></p> <p>Practice articulating your personal connection to the images you create.</p>

What's Going On?

- Any pixel with a value greater than or equal to the Maximum value will appear **white** in the image
- Any pixel with a value less than or equal to the Minimum value will appear **black** in the image
- Pixel with values in between the Minimum and Maximum will appear some shade of gray
- Changing the display does NOT change the actual information in the image, just how it appears to the person looking at it

CHALLENGE

Once youth have successfully recreated Tower1.GIF they should move on to the Challenge. Youth should try to figure out the steps on their own, but for this first challenge, facilitators should be prepared to prompt and guide youth through the specific actions:

1. Show the processed image (Tower2.GIF) and identify the goal: **Make the name of the building appear white with a black background.**
2. Open the image to be processed
3. Set "Max" value to match approximate pixel value of the letters in the word "PRUDENTIAL" (~500)
4. Set "Min" value to match approximate pixel value of the building *around* the word "PRUDENTIAL" (~350)
5. Save image with a unique, descriptive name (don't forget .GIF at the end!)

REFLECTION (Caption-writing and/or discussion)

6. Which view(s) of the Tower do you like best? Why?

This reflection helps youth prepare for their final exhibit by creating a label for a chosen image: Why did you choose to put this image in your exhibit? What should visitors know about how it was made?

Once youth have completed the challenge, they may change the color table of their image, and save a new version as a GIF with an appropriate descriptive name. See the Processing Challenge: Color Tables for an in-depth presentation of this tool and reflection activity.

NOTE: Some facilitators may wish simply to introduce the color tables as an add-on, rather than a separate activity.

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**Week 1 (Without A Telescope)**

**Lesson Objectives: *What do we need to get done today?***

**By the end of the lesson, the youth will:**

1. Get to know each other and the Facilitator
2. Take at least one image of a Moon or planet with MicroObservatory telescope

**Learning Objectives: *What will the youth learn today?***

**By the end of the lesson, the youth will have learned:**

1. How a telescope works
2. How to take images with the MicroObservatory telescopes
3. How to open and save images with the image processing software

**Agenda based on the lesson plan. Post in the room for the youth to see.**

- |  |                         |
|--|-------------------------|
| 1. Opening: Survey & Get To Know You Icebreaker      | 15 Minutes              |
| 2. Review Agenda and Astrophotography exhibit format | 5 Minutes<br>15 Minutes |
| 3. Kinesthetic Telescope                             | 5 Minutes               |
| 4. BREAK   | 10 Minutes              |
| 5. Take Images: Moon, Planets                        | 10 Minutes              |
| 6. Activity: Introduction to Image Information       | 20 Minutes              |
| 7. Processing Challenge: Prudential Tower            | 10 Minutes              |
| 8. Closing Circle                                    |                         |

**Preparation and Space Set up:**

Post daily agenda, 10-week program outline, and focus vocabulary for youth  
 Make sure software is installed and running on the computers  
 Load challenge images into appropriate folder on the computer  
 Create youth’s processed images folder on each machine  
 Prepare kinesthetic telescope cards and narration (Appendix E)

**Vocabulary** *What terms or concepts will you introduce in this session? Post these for the youth to see.*

Focus Vocabulary (to be posted): Telescope, image, pixel, brightness, image processing  
 Additional Vocabulary (to be aware of): Exposure time, aperture, mirror, shutter, detector

**Materials and Equipment**

*Physical resources:* Survey, writing utensils, observing logs, empty portfolio folders, vocabulary, kinesthetic telescope cards and narration (Appendix E)

*Electronic resources:* Stock challenge images (TowerChallenge.FITS)

*Computing resources:* Image processing software, Internet browser, folders set up on computer

<p><b>Week 1 Icebreaker: A Big Wind Blows</b> <span style="float: right;"><b>Time: 10 minutes</b></span></p>	
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY (1 minute)</p> <ul style="list-style-type: none"> <li>• All youth stand in a circle with the facilitator in the center. Use chairs or desks to mark each youth’s place in the circle.</li> <li>• The person in the middle says. “My name is [name] and I [something that is true about me]. (E.g. am wearing sneakers, have brown hair)</li> <li>• Everyone else for whom that fact is also true (e.g. everyone who is wearing sneakers or has brown hair) leaves their spot and tries to find a new spot. The person in the middle takes someone else’s spot.</li> <li>• The person who is left without a spot is in the middle</li> </ul> <p>DO THE ACTIVITY</p> <ul style="list-style-type: none"> <li>• Repeat the process above, being sure to include facts that cannot be seen just by looking at people (e.g. “is an only child,” “used to live in another state,” “likes basketball”)</li> </ul> <p>DISCUSS THE ACTIVITY</p> <ul style="list-style-type: none"> <li>• Astronomers make observations of objects in space, using telescopes and other tools.</li> <li>• Some properties of an object can be observed just by looking at them (shape, brightness, etc.). Others need more information to explain what they are like (what they are made of, how they move, etc.)</li> <li>• In this program, we will be making observations of objects in space and learning more about them through activities and research.</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To get to know each other</p> <p>To begin thinking about how to describe objects</p>

## Kids Capture Their Universe: An Astronomy Out-of-School Program

<b>Week 1 Activity:</b> Kinesthetic Telescope (More information/materials in Appendix E)	<b>Time:</b> 15 minutes
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY (5 minutes)</p> <ul style="list-style-type: none"> <li>• Facilitator reviews the vocabulary describing different parts of a telescope</li> <li>• Ask for volunteers to be each part of the telescope. Some parts (e.g. aperture) will need multiple people to create an appropriate formation</li> <li>• Set up the youth in the appropriate formation and designate one as a beam of light coming from an object in outer space.</li> <li>• Walk the beam through the telescope, narrating what happens to the light at each stage</li> </ul> <p>DO THE ACTIVITY (10 minutes)</p> <ul style="list-style-type: none"> <li>• Youth create their own model of the process, or recreate the process they just saw. Non-telescope youth can be beams of light, objects in space, or astronomers at the detector end of the telescopes.</li> <li>• Each part of the telescope must explain what he or she is doing. The light cannot move forward until it is given permission from the telescope                     <ul style="list-style-type: none"> <li>○ Light: travels from objects in space to the telescope</li> <li>○ Aperture: lets the light into the telescope</li> <li>○ Mirror: focuses the light toward the detector</li> <li>○ Shutter: lets the light through to the detector</li> <li>○ Detector: records the light to create an image</li> </ul> </li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To learn/review how light travels through a telescope</p> <p>To learn/review what different parts of the telescope does</p> <p>To work together as a team to create a human telescope</p>

**Materials Needed:** Narration of the process, telescope vocabulary words

## Kids Capture Their Universe: An Astronomy Out-of-School Program

<b>Week 1: Request images from MicroObservatory</b>		<b>Time: 5 minutes</b>
<ul style="list-style-type: none"><li>Week 1: facilitator models how to request an image using the Guest Observer Portal and record the request in the Observation Log</li></ul> <p><b>HOW TO REQUEST AN IMAGE</b></p> <ul style="list-style-type: none"><li>Open Internet browser</li><li>Go to <a href="http://www.microobservatory.org">www.microobservatory.org</a></li><li>Choose an activity (see list below)</li><li>Choose an object</li><li>Choose an exposure time (faint objects require longer exposure times)</li><li>Enter an email address (easy option is to use account created and monitored by facilitator, see page 6)</li><li>Record request in observing log</li><li>Confirm request</li></ul>	<p><b>Objective</b></p> <p>Take images of the Moon and planets for next time.</p>	

**Hint:** It will save you time if you write the URL on the board for youth to see (it is also written on their observing logs)

**Note:** The automated emails from the MicroObservatory server are sent around 1 p.m. the day AFTER images are requested.

### **Where will youth find the various telescope targets they need?**

Look within the following Guest Observer Portal activities to find the desired targets

- ***Moon (Telescope As Time Machine, Galileo)***
- ***Planets (Galileo, Telescope As Time Machine)***
- Stars & Star Clusters (Galileo, Telescope As Time Machine)
- Nebulae (Colorful Cosmos, Black Hole Hunt)
- Galaxies (Galaxies Galore, Black Hole Hunt)

Week 1 Activity: Introduction to image information		Time: 10 minutes
<p>INTRODUCTION (Open and Explore the Image)</p> <p>Youth do each action along with the facilitator</p> <ol style="list-style-type: none"> <li>1. Open the image processing software</li> <li>2. Click “File” &gt; “Open image on local disk...” and choose the image from the appropriate folder (TowerChallenge.FITS)</li> <li>3. Click “Window” &gt; “Image Info”</li> <li>4. Move cursor over the image and notice the changes in the Image Info window. Three possible answers. The third being the one to focus on:               <ol style="list-style-type: none"> <li>a. The picture in the view box changes</li> <li>b. The numbers next to “X” and “Y” change</li> <li>c. The number next to the word “Pixel” changes</li> </ol> </li> <li>5. Explain what is going on. Again, answer “c” is the one to focus on               <ol style="list-style-type: none"> <li>a. The view box allows us to see a closer view of the object</li> <li>b. The numbers next to “X” and “Y” tell us where we are in the image</li> <li>c. The “Pixel Value” number tells how bright that part of the image appears, or how much light is coming from that part of the object</li> </ol> </li> <li>6. CHALLENGE: Where in the image is the pixel value the highest? What value does it have? Where is it lowest?</li> <li>7. OPTIONAL EXPLORATION: How can youth get a better view of the individual pixels? (Answer: zoom tool—the magnifying glass icon at the top of the image)</li> </ol>	<p><b>Objective</b></p> <p>Learn how to open an image on the computer</p> <p>Use the mouse and “Image Info” window to get information about the image.</p> <p>(Optional) Use the zoom tool to see the pixels more closely</p>	

<b>Week 1 Processing Challenge:</b> Prudential Tower (Quick reference available on page C-2 of the curriculum)	<b>Time: 20 minutes</b> <b>(including reflection)</b>
<p><b>MODEL THE ACTIVITY</b></p> <p>Youth do each step along with the facilitator to achieve the activity goal: <b>To increase the contrast between the windows on the left side of the building and the building itself.</b></p> <ol style="list-style-type: none"> <li>1. Re-open the image TowerChallenge.FITS or return it to its original view by double clicking on the magnifying glass icon to zoom all the way out</li> <li>2. Make sure the “Image Info” window is open</li> <li>3. Click “Process” &gt; “Adjust Image...”</li> <li>4. Point out the “Max” and “Min” fields in the “Adjust Image” window and explain that changing these numbers changes the appearance of the image.</li> <li>5. Explain that you want to make the windows on the left side of the building appear white against a black background.</li> <li>6. Click on the main image window, and note in the “Image Info” window the approximate pixel value of the area that you want to appear white—windows.</li> <li>7. Enter that value (300) into the “Max” field (be sure to hit enter).</li> <li>8. Click on the main image window, and note in the “Image Info” window the approximate pixel value of the area of the image that you want to appear black—the surrounding building.</li> <li>9. Enter that value (275) into the “Min” field (be sure to hit Enter).</li> <li>10. Click on “File” &gt; “Save Image As...” &gt; “GIF” and choose the folder to save it in (e.g. “Week 1”)</li> <li>11. Save the file with a descriptive file name (e.g. NameTowerDate.GIF)</li> </ol>	<p style="text-align: center;"><b>Objective</b></p> <p>Learn how to change the contrast of an image using the “Adjust Image” tool.</p> <p>(Optional) Learn how to use false color tables to change the appearance of an image</p> <p>Learn how to save images with descriptive file names.</p> <ul style="list-style-type: none"> <li>• Object name</li> <li>• Youth name</li> <li>• Descriptive feature such as date or color of processing</li> <li>• File extension (.GIF) must be added explicitly.</li> </ul> <p><b>Additional Information:</b></p> <p>At the end of this activity, youth should reopen the program and the image to make they can find and access the image on their computer. If a file is not saved as a GIF with a .GIF extension, it will not open!</p> <p><b>Astrophotography exhibit Goal:</b></p> <p>Practice articulating your personal connection to the images you create.</p>

What's Going On?

- Any pixel with a value greater than or equal to the Maximum value will appear **white** in the image
- Any pixel with a value less than or equal to the Minimum value will appear **black** in the image
- Pixel with values in between the Minimum and Maximum will appear some shade of gray
- Changing the display does NOT change the actual information in the image, just how it appears to the person looking at it

CHALLENGE

Once youth have successfully recreated Tower1.GIF they should move on to the Challenge. Youth should try to figure out the steps on their own, but for this first challenge, facilitators should be prepared to prompt and guide youth through the specific actions:

1. Show the processed image (Tower2.GIF) and identify the goal: **Make the name of the building appear white with a black background.**
2. Open the image to be processed
3. Set “Max” value to match approximate pixel value of the letters in the word “PRUDENTIAL” (~500)
4. Set “Min” value to match approximate pixel value of the building *around* the word “PRUDENTIAL” (~350)
5. Save image with a unique, descriptive name (don't forget .GIF at the end!)

REFLECTION (Caption-writing and/or discussion)

6. Which view(s) of the Tower do you like best? Why?

This reflection helps youth prepare for their final exhibit by creating a label for a chosen image: Why did you choose to put this image in your exhibit? What should visitors know about how it was made?

Once youth have completed the challenge, they may change the color table of their image, and save a new version as a GIF with an appropriate descriptive name. See the Processing Challenge: Color Tables for an in-depth presentation of this tool and reflection activity.

NOTE: Some facilitators may wish simply to introduce the color tables as an add-on, rather than a separate activity.

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## Week 2 (Objects in Our Solar System)

**Lesson Objectives: *What do we need to get done today?***

**By the end of the lesson, the youth will:**

1. Process and save at least one image of the Moon (with caption!)
2. Create an astronomy poem

**Learning Objectives: *What will the youth learn today?***

**By the end of the lesson, the youth will have learned:**

1. How to use the sharpen and zoom tools
2. How to make detailed observations
3. What sorts of words can help people understand astronomy images
4. Information about objects in our solar system

**Agenda based on the lesson plan. Post in the room for the youth to see.**

- |   |            |
|---|------------|
| 1. Opening: What’s Different? Icebreaker  | 10 Minutes |
| 2. Review Agenda and Introduce Vocabulary | 5 Minutes  |
| 3. Processing Challenge: Moon             | 25 Minutes |
| 4. Take images: Nebulae, Stars            | 5 Minutes  |
| 5. BREAK                                  | 5 Minutes  |
| 6. Creative Challenge: Astro Poetry       | 25 Minutes |
| 7. Closing Circle                         | 15 Minutes |

**Preparation and Space Set up:**

Post daily agenda, 10-week program outline, and focus vocabulary for youth  
 Make sure software and processed images are still on computers  
 Retrieve youth’s requested images from last week and load them onto the computers

**Vocabulary** *What terms or concepts will you introduce in this session? Post these for the youth to see.*

Focus Vocabulary: Moon, Planet, Our Solar System, Zoom  
 Additional Vocabulary: Crater, Sharpen, Crop, False Color Table

**Materials and Equipment**

*Physical resources:* Observing logs, processing logs, index cards, markers, astronomical images

*Electronic resources:* Moon & planet images requested last week, Stock Moon challenge image (MoonChallenge.FITS)

*Computing resources:* Electronic folders, processing software, Internet browser on each computer

## Kids Capture Their Universe: An Astronomy Out-of-School Program

**Week 2 Icebreaker:** Noticing Detail – What’s different? **Time:** 10 minutes

	<b>Objective</b>
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY (2 minutes)</p> <ul style="list-style-type: none"><li>• All youth line up facing the front of the classroom. facilitator stands facing the youth.</li><li>• Youth examine the facilitator and observe as many things about his/her appearance as they can.</li><li>• After 30 seconds, youth turn around to face the back of the classroom while the facilitator changes a small but noticeable feature on his/her person (e.g. takes off name tag, rolls up shirt sleeve, changes hair style)</li><li>• When given the “all clear” by the facilitator, youth turn around and try to identify what has changed.</li></ul> <p>DO THE ACTIVITY (6 minutes)</p> <ul style="list-style-type: none"><li>• The person who correctly identifies the change becomes the next person to make a change.</li><li>• Repeat until everyone has had a turn</li></ul> <p>DISCUSS THE ACTIVITY (2 minutes)</p> <ul style="list-style-type: none"><li>• Astronomers must notice details in images and make very careful observations to determine what objects are like and how they change.</li><li>• In this program, youth will be examining images of their own and explaining to their audience what they observe.</li></ul>	<p>To begin looking carefully at objects being observed</p>

<p><b>Week 2 Processing Challenge: The Moon</b> (Quick reference available on page C-3 of the curriculum)</p> <p><b>Time: 25 minutes</b> (including reflection)</p>	
<p><b>INTRODUCTION</b></p> <ol style="list-style-type: none"> <li>Review how to open the software, images, and image windows (Image Info, Adjust Image)</li> <li>Open image MoonChallenge.FITS</li> <li>Explain the goal of the activity: <b>To get a better, more detailed view of a chosen crater on the surface of the Moon</b></li> </ol> <p><b>MODEL ACTIVITY</b> (youth follow along)</p> <ol style="list-style-type: none"> <li>Click “Process” &gt; “Sharpen”</li> <li>Click on the ‘zoom’ tool (magnifying glass)</li> <li>Click on the crater to be observed (middle of image)</li> <li>Adjust the contrast on the image in the by moving the triangles in the “Adjust Image” window</li> <li>Demonstrate the use of color tables and re-adjust the contrast if necessary/desired.</li> <li>Once the image looks how you want it, click on the ‘select area’ tool (dotted rectangle)</li> <li>Select the area to be cropped by clicking on one corner of the desired area and dragging the mouse to the opposite corner and then releasing</li> <li>Click “Process” &gt; “Crop”</li> <li>Save the new image as a GIF file with a descriptive name</li> </ol> <p><b>Note:</b> Cropping should always be the LAST thing that you do before saving an image. The cropped image will open up in a new window and the zoom tool will not work the same way as it does in the original.</p>	<p><b>Objective</b></p> <p>Review how to open and save an image.</p> <p>Learn how to zoom in on an image</p> <p>Learn how to crop an image</p> <p>Practice using the “Adjust Image” tool to change the contrast of an image in a new way</p> <p>Learn how to sharpen an image</p> <p>Apply color tables to change the appearance of an image</p> <p><b>Additional Information</b></p> <p>The Sharpen tool is rarely used for processing images other than the Moon. As such, it may be skipped.</p> <p>Because the color tables are so popular, youth will likely have discovered them during the first week of processing challenges. If they have not, introduce them as an add-on this week.</p> <p><b>Astrophotography exhibit Goals:</b></p> <p>Use teamwork to communicate information about an image to an audience.</p> <p>Practice writing captions.</p>

### YOUTH CHALLENGE

The challenge is presented in gray scale so that youth can focus on the contrast, zooming, and cropping tools. Color tables can be added later.

1. Show the processed image (Moon2.GIF) and identify the goal: **Create a sharp detailed view of craters at the bottom of the Moon**
2. Prompt and assist youth in figuring out how to complete the challenge on their own/in pairs.
3. Sharpen the image
4. Zoom in on the chosen area
5. Adjust the contrast by moving the triangles/changing the “Min” and “Max” values in the “Adjust Image” window.
6. Select and crop the chosen area of the image
7. Save the cropped image as a GIF file

### OPTIONAL CHALLENGE/FREE PROCESSING

If desired, create another challenge image with a false color table. See “Color Tables” challenge for more info.

1. Experiment with the various tools (including color tables) using the telescope images requested last week.
2. Save all processed images as GIF files with unique, descriptive names, and record in the processing log how you made each image.

### REFLECTION (Caption-writing/gallery interviews)

1. Look at another image that has been created. Interview the person who created it. How did they make it? What do they like about it?
2. Prepare a caption for your partner’s image and share it with the group

Steps 3-6 are listed for the facilitator’s reference only—youth must make a good faith effort to figure things out before facilitators reveal the “answers.”

NOTE: Youth do not need to match the contrast settings exactly, but for reference, the “Min” and “Max” values in the presented image were set to match the pixel values of the background (~280) and bright spots on the surface (~550).

With limited time, it is tempting to skip the caption-writing part of the exercise, but this will be a key element of the final projects.

The interview model is useful because it helps youth articulate what they or other people did to create an image. During the final Astrophotography exhibit, youth will be responsible for presenting each other’s images as well as their own.

<b>Week 2: Request images from MicroObservatory</b>		<b>Time: 5 minutes</b>
<p><b>HOW TO REQUEST AN IMAGE</b></p> <ul style="list-style-type: none"> <li>• Open Internet browser</li> <li>• Go to <a href="http://www.microobservatory.org">www.microobservatory.org</a></li> <li>• Choose an activity (see list below)</li> <li>• Choose an object</li> <li>• Choose an exposure time (faint objects require longer exposure times)</li> <li>• Enter an email address (easy option is to use account created and monitored by facilitator, see page 6)</li> <li>• Record request in observation log</li> <li>• Confirm request</li> </ul>	<p style="text-align: right;"><b>Objective</b></p> <p>Take images of stars and nebulae for next time.</p> <p><b>Hint:</b> It will save you time if you write the URL on the board for youth to see (it is also written on their observing logs)</p>	

**Telescope Targets (Guest Observer Portal Activity Locations)**

- Moon (Telescope As Time Machine, Galileo)
- Planets (Galileo, Telescope As Time Machine)
- **Stars & Star Clusters (Galileo, Telescope As Time Machine)**
- **Nebulae (Colorful Cosmos, Black Hole Hunt)**
- Galaxies (Galaxies Galore, Black Hole Hunt)

## Kids Capture Their Universe: An Astronomy Out-of-School Program

<b>Week 2 Creative Challenge: AstroPoetry</b>		<b>Time: 20 minutes</b>
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY (facilitator) (5 minutes)</p> <ul style="list-style-type: none"> <li>Facilitator shows an astronomical image taken by a professional or amateur astronomer/astrophotographer.</li> <li>Ask youth what they know about the image and what words they would use to describe it (e.g. bright, swirling) or what it reminds them of (e.g. marble, pancake, hula hoop).</li> <li>Facilitator records one word per index card.</li> <li>Facilitators rearrange words to create a poem and read the poem aloud.</li> </ul> <p>DO THE ACTIVITY (Youth) (15 minutes)</p> <ul style="list-style-type: none"> <li>Split into two teams—each team is given/chooses an astronomical image about which to create their poem</li> <li>5 minutes to brainstorm words (include nouns, verbs, and adjectives!)</li> <li>5 minutes to create poem (can add in connecting words if desired, or add pre/suffixes to existing words)</li> <li>5 minutes to share &amp; reflect</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To notice details in an astronomical image.</p> <p>To creatively express what is known objects in space.</p>	

**Materials needed:** Index cards, markers, astronomical images

**Other notes:**

- Groups can compete to make the most descriptive poem about the same object, or they can each work on a different object (chosen or assigned)
- Poems can include astronomical information if it is known
- Youth should practice good oral presentation skills when they present their poems—speaking slowly, loudly, and clearly, while showing their image with the poem.

**Week 3 (Stars and Nebulae)**

**Lesson Objectives: *What do we need to get done today?***

**By the end of the lesson, the youth will:**

1. Process and save at least one image of a nebula (with caption!)
2. Work together to create kinesthetic models

**Learning Objectives: *What will the youth learn today?***

**By the end of the lesson, the youth will have learned:**

1. What stars and nebulae are
2. How the “Adjust Image...” tool changes the contrast of an image

**Agenda based on the lesson plan. Post in the room for the youth to see.**

- |  |            |
|--|------------|
| 1. Opening: Human Machines Teambuilding      | 15 Minutes |
| 2. Review Agenda and Introduce Vocabulary    | 5 Minutes  |
| 3. Processing Activity: Orion Nebula         | 10 Minutes |
| 4. Processing Challenge: Star Cluster        | 10 Minutes |
| 5. Take images: Galaxies                     | 5 Minutes  |
| 6. BREAK                                     | 5 Minutes  |
| 7. Creative Challenge: Kinesthetic Astronomy | 25 Minutes |
| 8. Closing Circle                            | 10 Minutes |

**Preparation and Space Set up:**

Post daily agenda, 10-week program outline, and focus vocabulary for youth  
 Retrieve youth’s requested images from last week and load them onto the computers  
 Choose an open area (outside or indoors) for the kinesthetic astronomy activity

**Vocabulary** *What terms or concepts will you introduce in this session? Post these for the youth to see.*

Focus Vocabulary: Star, Nebula, Contrast, Gravity  
 Additional Vocabulary: Our Milky Way Galaxy

**Materials and Equipment**

*Physical resources:* Portfolio folders, observing logs, processing logs, token astronomical images for illustrating stellar life cycle (Appendix A)

*Electronic resources:* Images of stars and nebulas, Stock challenge images (NebulaChallenge.FITS and StarClusterChallenge.FITS)

*Computing resources:* Image processing software, Internet browser, electronic image folders

Kids Capture Their Universe: An Astronomy Out-of-School Program

<b>Week 3 Icebreaker: Human Machines (Teambuilding) Time: 15 minutes</b>	
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY (5 minutes)</p> <ul style="list-style-type: none"> <li>• Facilitators work together to kinesthetically create a machine, such as an old-fashioned grandfather clock (one person is the face; the other is the pendulum)</li> <li>• Help the youth to create their first machine:             <ul style="list-style-type: none"> <li>○ Computer: two youth can make the outline of a screen with their arms; everyone else squats down to become buttons on the keyboard</li> <li>○ Microwave: two youth create the compartment, one youth is a rotating plate inside, others are buttons, plugs, etc.</li> </ul> </li> </ul> <p>DO THE ACTIVITY (All together or in small groups)</p> <ul style="list-style-type: none"> <li>• Challenge youth to create other machines, such as a telephone, toaster, television, carousel, blender, bicycle, etc. (be creative...choose your own!)</li> <li>• Each youth becomes one part of the machine, NOT the humans operating it, unless necessary</li> </ul> <p>DISCUSS THE ACTIVITY</p> <ul style="list-style-type: none"> <li>• What was hard about this activity? (Listening to others, communicating your ideas, working together, people forgetting to do their action, etc.)</li> <li>• Astronomers have to share ideas and work together to build telescopes and interpret their data.</li> <li>• In this program, we will need everyone’s input to make our exhibit a success. If one person doesn’t do their part, the process won’t work!</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To become comfortable working together toward a common goal.</p> <p>To improve communication and cooperation among youth.</p>

<p><b>Week 3 Processing Activity: Orion Nebula</b> <span style="float: right;"><b>Time: 5-10 minutes</b></span>                  (Quick reference available on page C-4 of the curriculum)</p>	
<p><b>MODEL THE ACTIVITY</b></p> <p>Youth follow along on their own computers, through both examples</p> <ol style="list-style-type: none"> <li>1. Open the image processing software and the image “NebulaChallenge.FITS”</li> <li>2. Open the “Image Info” window, and the “Adjust Image” window</li> <li>3. Point out the buttons at the bottom of the “Adjust Image” window (“Linear,” “Log,” “Auto”) and explain that these are shortcuts that we can use to bring out interesting parts of an image.</li> </ol> <p><b>EXAMPLE 1 (Nebula1.GIF)</b></p> <ol style="list-style-type: none"> <li>1. Click the “Auto” button in the “Adjust Image” window and ask youth to describe the resulting image</li> <li>2. Ask if anyone remembers how to set the background of the image to black and, at their prompting, or as a reminder, guide them through setting the “Min” field to the approximate pixel value of the background (~289)</li> <li>3. Point out the newly revealed features around the edges of the cloud (wisps of gas on the right, etc.)</li> <li>4. Crop and save image as a GIF with a descriptive name</li> </ol>	<p style="text-align: center;"><b>Objective</b></p> <p>Learn how to use the “Auto” and “Log” functions of the “Adjust Image” tool</p> <p>Remember how to change the contrast in an image, zoom, and crop</p> <p><b>Additional Information</b></p> <p>Because the “Auto” function is quick and straightforward (at least mechanically), two examples are given using the Orion Nebula image. Both examples will make minor adjustments to the appearance of the image to improve the view after using the “Auto” function.</p> <p>The challenge itself will use a different image, but the same procedure.</p>

### EXAMPLE 2 (Nebula2.GIF)

1. Re-open image NebulaChallenge.FITS
2. Choose “Log” and click the “Auto” button in the “Adjust Image” window...what do youth see?
3. Explain that you want a better view of what is going on at the center of the nebula
4. Zoom in on the center of the nebula
5. Ask youth to look at the “Image Info” window and describe the range of pixel values in that area
6. Set “Max” field to the highest pixel value in the image (~4000, at the heart of the nebula)
7. Point out the newly revealed details of the cloud in the image (i.e. stars and texture)
8. Crop and save the image as a GIF with a descriptive name

### What’s Going On?

- **Auto** looks at the range of pixel values in the image and sets the contrast range (Min/Max) to display high pixel values as bright areas of the image and low pixel values as dark areas
- **Linear** is the default scale: low pixel values appear darker and high values appear brighter, in roughly even intervals
- **Log** scale is an exponential scale. It displays a wide range of brightness for high pixel values and allows you to see more details at both ends of the range
- Generally, log scale is the best way to view images of objects like galaxies and nebulae

<p><b>Week 3 Processing Challenge: Star Cluster</b> <span style="float: right;"><b>Time: 10-15 minutes</b></span>                  (Quick reference available on page C-5 of the curriculum)</p>	
<p><b>CHALLENGE</b></p> <p>Youth work independently or in pairs to figure out how to make StarClusterChallenge.FITS look like StarCluster1.GIF</p> <ol style="list-style-type: none"> <li>1. Open StarClusterChallenge.FITS, show the processed image (StarCluster1.GIF) and identify the challenge: <b>Make visible as many stars as possible in the Hercules star cluster.</b></li> <li>2. Remind youth about what they did to make the details of the image of the Orion Nebula visible and use this information as prompts to complete the following:</li> <li>3. Click the “Auto” button in the “Adjust Image” window</li> <li>4. Set the “Min” field to the approximate pixel value of the background (~295)</li> <li>5. Click the “Log” in “Adjust Image” window</li> <li>6. Set “Max” field to the highest pixel value in the image (~950, at the center of the cluster)</li> <li>7. Crop and save the image as a GIF file with a descriptive name</li> </ol> <p><b>FREE PROCESSING AND REFLECTION</b></p> <p>Youth should process images of other objects using the various processing tools on their own telescope images. Remember to save all processed images as GIF files with unique, descriptive names, and record in the processing log each image was made.</p> <p>At the end of the session, everyone should discuss, caption, and reflect on the processed images with partners or in the large group. Shout-outs welcome.</p>	<p style="text-align: center;"><b>Objective</b></p> <p>Practice using the image processing software to bring out detail in an image</p> <p><b>Additional Information</b></p> <p>Although false color tables are not an explicit part of this challenge, youth are encouraged to experiment with color tables and/or the invert color tool in creating their final, saved images.</p> <p><b>Astrophotography exhibit Goals:</b></p> <p>To make detailed observations about an image</p> <p>To practice sharing observations about an image</p>

<b>Week 3: Request images from MicroObservatory</b>		<b>Time: 5 minutes</b>
<p><b>HOW TO REQUEST AN IMAGE</b></p> <ul style="list-style-type: none"> <li>• Open Internet browser</li> <li>• Go to <a href="http://www.microobservatory.org">www.microobservatory.org</a></li> <li>• Choose an activity (see list below)</li> <li>• Choose an object</li> <li>• Choose an exposure time (faint objects require longer exposure times)</li> <li>• Enter an email address (easy option is to use account created and monitored by facilitator, see page 6)</li> <li>• Record request in observation log</li> <li>• Confirm request</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>Take images of galaxies for next time.</p> <p><b>Hint:</b> It will save you time if you write the URL on the board for youth to see (it is also written on their observing logs)</p>	

**Telescope Targets (Guest Observer Portal Activity Locations)**

- Moon (Telescope As Time Machine, Galileo)
- Planets (Galileo, Telescope As Time Machine)
- Stars & Star Clusters (Galileo, Telescope As Time Machine)
- Nebulae (Colorful Cosmos, Black Hole Hunt)
- **Galaxies (Galaxies Galore, Black Hole Hunt)**

<p><b>Week 3 Creative Challenge: Kinesthetic Astronomy</b> <span style="float: right;"><b>Time: 25 minutes</b></span>                  (More information available in Appendix D)</p>	
<p><b>Procedure</b></p> <ul style="list-style-type: none"> <li>• Review the day’s vocabulary, explaining that stars, like nebulae, are made of gas and dust. They are born inside giant star-forming nebulae and when they die they leave behind other types of nebulae. Each youth will represent a clump of gas in the star or nebula.</li> <li>• Facilitator shows an astronomical image and explains the process that each object is going/has gone through.</li> <li>• Facilitator helps youth recreate that process kinesthetically.                         <ul style="list-style-type: none"> <li>○ Star Forming Nebula: Clumps of gas are pulled together by the force of gravity, forming stars</li> <li>○ Star: Fusion in the core of a star creates an outward pressure that balances the force of gravity in the outer layers.</li> <li>○ Planetary Nebula: The core of an ordinary star collapses and the outer layers drift outward into space.</li> <li>○ Supernova (Remnant): The core of a very massive star collapses and the outer layers fall inward and bounce off the core and explode outward, releasing energy.</li> </ul> </li> </ul> <p>See additional background information for a diagram of youth motion in each stage.</p>	<p style="text-align: center;"><b><i>Objective</i></b></p> <p>To learn about different types of nebulae</p> <p>To create a kinesthetic model of astronomical phenomena</p>

**Materials Needed:** Astronomical images and/or poster showing stellar life cycle objects (star-forming nebula, stars (main sequence & red giant), planetary nebula, supernova remnant)

**Other notes:**

- Rather than using this activity to teach about the overarching life cycle of stars, this approach focuses on interpreting what can be seen in images.
- See Appendix D for detailed background information and additional resources

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<b>Week 4 (Galaxies)</b>															
<p><b>Lesson Objectives: <i>What do we need to get done today?</i></b>  <b>By the end of the lesson, the youth will:</b></p> <ol style="list-style-type: none"> <li>1. Process and save at least one image of a galaxy (with caption!)</li> <li>2. Create a three-dimensional astronomy sculpture</li> </ol>															
<p><b>Learning Objectives: <i>What will the youth learn today?</i></b>  <b>By the end of the lesson, the youth will have learned:</b></p> <ol style="list-style-type: none"> <li>1. What a galaxy is</li> <li>2. How physical perspectives affect our view of objects in space</li> <li>3. How to give clear instructions to a peer</li> </ol>															
<p><b>Agenda based on the lesson plan. Post in the room for the youth to see.</b></p> <table border="0"> <tr> <td>1. Opening: Blind Sculpture Challenge</td> <td style="text-align: right;">15 Minutes</td> </tr> <tr> <td>2. Review Agenda and Introduce Vocabulary</td> <td style="text-align: right;">5 Minutes</td> </tr> <tr> <td>3. Processing Challenge: Galaxies</td> <td style="text-align: right;">25 Minutes</td> </tr> <tr> <td>4. Take images: Miscellaneous</td> <td style="text-align: right;">5 Minutes</td> </tr> <tr> <td>5. BREAK</td> <td style="text-align: right;">5 Minutes</td> </tr> <tr> <td>6. Creative Challenge: Astro Sculpture</td> <td style="text-align: right;">25 Minutes</td> </tr> <tr> <td>7. Closing Circle</td> <td style="text-align: right;">10 Minutes</td> </tr> </table>		1. Opening: Blind Sculpture Challenge	15 Minutes	2. Review Agenda and Introduce Vocabulary	5 Minutes	3. Processing Challenge: Galaxies	25 Minutes	4. Take images: Miscellaneous	5 Minutes	5. BREAK	5 Minutes	6. Creative Challenge: Astro Sculpture	25 Minutes	7. Closing Circle	10 Minutes
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<p><b>Preparation and Space Set up:</b>                      Post daily agenda, 10-week program outline, and focus vocabulary for youth                      Retrieve youth’s requested images from last week and load them onto the computers                      Set up work space (and supplies) for 3D model construction</p>															
<p><b>Vocabulary</b> <i>What terms or concepts will you introduce in this session? Post these for the youth to see.</i></p> <p>Focus Vocabulary: Galaxy, Universe, Noise, Gravity</p>															
<p><b>Materials and Equipment</b></p> <p><i>Physical resources:</i> Portfolio folders, observing and processing logs, craft supplies (including clay for blind sculpture challenge), writing utensils</p> <p><i>Electronic resources:</i> Youth’s requested images of galaxies from last week, Stock challenge image (GalaxyChallenge.FITS)</p> <p><i>Computing resources:</i> Image processing software, Internet browser, electronic image folders</p>															

**Kids Capture Their Universe: An Astronomy Out-of-School Program**

<p><b>Week 4 Icebreaker: Blind Sculpture (Teambuilding)      Time: 10 minutes</b></p>	
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY (2 minutes)</p> <ul style="list-style-type: none"> <li>• Facilitator creates a sculpture by piecing together multiple basic shapes out of a blob of clay.</li> <li>• Facilitator then describes the sculpture to the TL, who recreates it out of another blob of clay.</li> </ul> <p>DO THE ACTIVITY (6 minutes)</p> <ul style="list-style-type: none"> <li>• Youth sit back-to-back and each create a sculpture with at least two components</li> <li>• Youth take turns describing their sculptures for their partners to recreate.</li> <li>• (Optional) Youth can ask clarifying questions.</li> </ul> <p>DISCUSS THE ACTIVITY (2 minutes)</p> <ul style="list-style-type: none"> <li>• What could your partner have said that would have helped you create a better replica of their sculpture?</li> <li>• Good science involves designing an experiment or project in a way that allows others to reproduce it. Astronomers have to be very clear about ideas and models so that everyone working on the project is on the same page.</li> <li>• In this program, everyone will have their own ideas for what they mean by the same term, and will need to clearly communicate what they want to happen. (For example, if someone says to “make a star,” does that mean a five-pointed object or a round ball, like stars in space?)</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To practice clear communication.</p> <p>To practice listening and asking questions about what other people are saying.</p>

**Materials: Clay**

<b>Week 4 Processing Challenge: Whirlpool &amp; Other Galaxies</b> <b>Time: 25 minutes</b> (Quick reference available on page C-5 of the curriculum)	
<p>MODEL THE ACTIVITY (5 minutes)</p> <p>Because this is the final week of processing challenges, youth will be encouraged to review their own knowledge in both the activity and the challenge.</p> <ol style="list-style-type: none"> <li>1. Show youth the processed image (Galaxy1.GIF) and identify the challenge: <b>To create a clear, detailed image of another galaxy outside of the Milky Way</b></li> <li>2. Open image GalaxyChallenge.FITS and encourage youth to provide step-by-step guidance on how to best process the image (see steps below)</li> <li>3. Open the “Image Info” and “Adjust Image” windows</li> <li>4. Choose “Log” and click the “Auto” button in the “Adjust Image” window</li> <li>5. Adjust the “Max” value by moving the upper triangle in the “Adjust Image” window</li> <li>6. Once the image looks the way the facilitator and youth want, announce that it is time for the final new image processing tool of the program.</li> <li>7. Click on “Process” &gt; “Reduce Noise” to get rid of the background “fuzz” in the image and make the stars in our own Milky Way galaxy stand out clearly</li> <li>8. Zoom in, crop, and save the image as a GIF with a unique, descriptive name.</li> </ol> <p>What’s Going On?</p> <ul style="list-style-type: none"> <li>• The <b>Reduce Noise</b> tool essentially blurs the image, so that individual pixels in the image are blended with the surrounding pixels</li> <li>• This actually changes the image data (pixel values) but is a useful tool for helping youth distinguish between stars and “background fuzz”</li> <li>• Note that all individual stars in these images are <i>inside</i> our own Milky Way Galaxy</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>Learn how to use the “Reduce Noise” tool</p> <p>Apply all processing tools to the images taken during the program</p> <p style="text-align: center;"><b>Additional Information</b></p> <p>For an added challenge, change the color table and/or invert the image. Can youth replicate the final view?</p> <p style="text-align: center;"><b>Astrophotography exhibit Goals:</b></p> <p>To make detailed observations about an image</p> <p>To practice sharing observations about an image</p>

### CHALLENGE (10 minutes)

**Goal: For youth to process one of their own images and teach someone else how to reproduce it.**

1. Now that youth have learned how to use the basic tools of the image processing software, they are free to apply any or all of them to their own telescope images.
2. Youth take approximately 2 minutes each to process one of their own images using the full suite of processing tools (adjust contrast, sharpen, reduce noise, zoom, crop, color tables, etc.)
3. In pairs, take turns examining and recreating the other person/team's image.
4. Remember to save every processed image as a GIF with a unique, descriptive name.
5. Together, the pairs should create captions for each image, using the processing log prompts

### FREE PROCESSING AND REFLECTION (10 minutes)

1. With any remaining time in the session, youth continue to process their own telescope images
2. As an additional challenge, choose two galaxies that look very different and process them using the same steps and tools.
3. Be sure to leave time at the end of the session for shout outs and caption/image sharing

<b>Week 4: Request images from MicroObservatory</b>		<b>Time: 5 minutes</b>
<p><b>HOW TO REQUEST AN IMAGE</b></p> <ul style="list-style-type: none"> <li>• Open Internet browser</li> <li>• Go to <a href="http://www.microobservatory.org">www.microobservatory.org</a></li> <li>• Choose an activity (see list below)</li> <li>• Choose an object</li> <li>• Choose an exposure time (faint objects require longer exposure times)</li> <li>• Enter an email address (easy option is to use account created and monitored by facilitator, see page 6)</li> <li>• Record request in observation log</li> <li>• Confirm request</li> </ul>	<p style="text-align: right;"><b>Objective</b></p> <p>Take images for next time (variety of astronomical objects).</p> <p><b>Hint:</b> It will save you time if you write the URL on the board for youth to see (it is also written on their observing logs)</p>	

**Telescope Targets (Guest Observer Portal Activity Locations)**

- Moon (Telescope As Time Machine, Galileo)
- Planets (Galileo, Telescope As Time Machine)
- Stars & Star Clusters (Galileo, Telescope As Time Machine)
- Nebulae (Colorful Cosmos, Black Hole Hunt)
- Galaxies (Galaxies Galore, Black Hole Hunt)

**Note:** This is the last week that youth will use the online telescopes to request images!

Week 4 Creative Challenge: AstroSculpture		Time: 25 Minutes
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY (Facilitators) (5 minutes)</p> <ul style="list-style-type: none"> <li>• Show an image of the Moon</li> <li>• Hold up a paper plate and a balloon/clay ball—ask youth which one is a better representation of the object in the image and ask them to explain why.</li> <li>• Ask youth for ideas about how to make their chosen model look more like the actual object in space (draw on craters, make dents, sprinkle with dust, etc.)</li> </ul> <p><b>OR:</b> Show a pre-made model of a galaxy (CD with cotton ball center, for example) and demonstrate how it can be viewed so that it looks like different MicroObservatory images (face-on, edge-on, close, far away).</p> <p>DO THE ACTIVITY (Youth) (20 minutes)</p> <ul style="list-style-type: none"> <li>• Split into small groups (2-3 youth)</li> <li>• Each group chooses an image taken by a professional or amateur astronomer/astrophotographer and creates a three dimensional model of the object in the photo</li> <li>• Facilitators help the groups by asking leading questions: What do you think this object feels like? Is it all one piece? What is it made of? What is this object doing? How can you represent that process?</li> <li>• Each group shares their model (5 minutes)</li> </ul>	<p><b>Objective</b></p> <p>To explore the relationship between three-dimensional objects and two-dimensional images.</p> <p>To creatively interpret the nature of astronomical objects.</p>	

**Materials Needed:** Astronomical images, craft supplies of different shapes (flat, round, pointy, etc.), textures (smooth, stretchy, gritty, soft, etc.), and appearances (shiny, translucent, dark, bright, etc.), craft tools (scissors, glue, tape, stapler, markers, etc.)

**SUGGESTIONS FOR CRAFT SUPPLIES:** Colored construction paper, box of clay, cotton balls, yarn, fabric, netting (tulle), fiber batting, fiber batting (quilt filler), glow string, bubble wrap, wax paper, aluminum foil, plastic wrap, balloons, pipe cleaners, craft sticks, small styrofoam or squishy balls (e.g. pom-poms) of various sizes, paper plates, toilet paper

<b>Week 5</b>											
<p><b>Lesson Objectives: <i>What do we need to get done today?</i></b>  <b>By the end of the lesson, the youth will:</b></p> <ol style="list-style-type: none"> <li>1. See a telescope?</li> <li>2. See an exhibit?</li> <li>3. Meet astronomers?</li> </ol>											
<p><b>Learning Objectives: <i>What will the youth learn today?</i></b>  <b>By the end of the lesson, the youth will have learned:</b></p> <ol style="list-style-type: none"> <li>1. How astronomers process images?</li> <li>2. What makes an exhibit interesting and/or effective?</li> </ol>											
<p><b>Agenda based on the lesson plan. Post in the room for the youth to see.</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;">1. Opening Circle</td> <td style="text-align: right;">10 Minutes</td> </tr> <tr> <td>2. Field Trip, Part I</td> <td style="text-align: right;">20 Minutes</td> </tr> <tr> <td>3. BREAK</td> <td style="text-align: right;">5 Minutes</td> </tr> <tr> <td>4. Field Trip, Part II</td> <td style="text-align: right;">20 Minutes</td> </tr> <tr> <td>5. Closing Circle</td> <td style="text-align: right;">5 Minutes</td> </tr> </table>		1. Opening Circle	10 Minutes	2. Field Trip, Part I	20 Minutes	3. BREAK	5 Minutes	4. Field Trip, Part II	20 Minutes	5. Closing Circle	5 Minutes
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<p><b>Preparation and Space Set up:</b></p> <p>Depends on field trip</p>											
<p><b>Vocabulary</b> <i>What terms or concepts will you introduce in this session? Post these for the youth to see.</i></p> <p>Depends on field trip</p>											
<p><b>Materials and Equipment</b></p> <p><i>Physical resources:</i> Depends on field trip...paper and writing utensils for taking notes?</p> <p><i>Electronic resources:</i> Depends on field trip...astronomical images?</p> <p><i>Computing resources:</i> Depends on field trip...image processing tools?</p>											

See next page for suggestions of possible field trip destinations

## Kids Capture Their Universe: An Astronomy Out-of-School Program

### **Field Trip Ideas for Week 5** (could be week 4 or 6 if desired; adjust schedule accordingly)

The purpose of the field trip is to give youth an experience with /exposure to the authentic work of adults which is reflected in the work of the program.

Obviously, we encourage you to share more directly what you do in your profession or vocation, which has some connection to what the youth do during “Kids Capture Their Universe”

Ideas (some tried previously) include the following:

- Visit to Harvard-Smithsonian Center for Astrophysics to see the MicroObservatory telescopes in person.
- Visit to lab/research center to interact with astronomers using similar image processing tools in their work
- Visit to museum to observe the work of a curator in organizing an exhibit and to get ideas for youth’s own exhibition
  - The Museum of Science, Boston, astronomy gallery outside the planetarium is free
  - Other local museums may not have astronomy displays, but can still be relevant to the program—In Boston, Museum of Fine Arts, MIT Museum
- Visit to a workshop/observatory for making telescopes / observing
- Visit to a planetarium (could include exhibits?)
- Visit to lab/research center where you work.
- Visit to any company / lab where image processing is used on a regular basis (medical imaging, x-ray technician, etc.)

Youth are encouraged to choose at least one question and associated image they have processed to ask any experts they may encounter during the field trip.

Arrange for youth to meet you at the field trip location at a certain time. Be sure to leave “wiggle room” for traffic or transportation delays.

**Week 6**

**Lesson Objectives: *What do we need to get done today?***

**By the end of the lesson, the youth will:**

1. Process the remaining images in their portfolios
2. Write the remaining captions for their images
3. Choose images for their exhibit displays

**Learning Objectives: *What will the youth learn today?***

**By the end of the lesson, the youth will have learned:**

1. A strategy for providing feedback to their peers
2. How to make choices using their own and other people’s opinions
3. That all their processing challenges play a role in the final exhibit!

**Agenda based on the lesson plan. Post in the room for the youth to see.**

- |   |            |
|---|------------|
| 1. Opening: Review Field Trip and write Thank You cards | 5 Minutes  |
| 2. Review Agenda and Vocabulary                         | 5 Minutes  |
| 3. Challenge: Final Processing & Caption Writing        | 25 Minutes |
| 4. BREAK  | 5 Minutes  |
| 5. Activity: “Best in Show” peer feedback               | 20 Minutes |
| 6. Activity: Develop exhibit image groups for           | 15 Minutes |
| Astrophotography exhibit                                | 15 Minutes |
| 7. Closing Circle                                       |            |

**Preparation and Space Set up:**

Post daily agenda, 10-week program outline, and focus vocabulary for youth  
 Retrieve youth’s requested images from Week 4 and load them onto the computers  
 If desired, fill out “Image Template” worksheet with existing images and accompanying captions  
 Print out document and place pages in respective youth’s portfolio folders

**Vocabulary** *What terms or concepts will you introduce in this session? Post these for the youth to see.*

No new vocabulary, but words from past weeks should be posted  
 Focus Vocabulary: zoom, contrast, brightness, noise  
 Additional Vocabulary: crop, pixel, false color table

**Materials and Equipment**

*Physical resources:* Youth folders (with all existing images, captions, and observing logs), blank processing logs, Post-Its, colored stickers for voting, writing utensils, Astrophotography exhibit Voting template slips (if desired)

*Electronic resources:* Full supply of images requested by youth, loaded onto computers

*Computing resources:* Image processing software

## Kids Capture Their Universe: An Astronomy Out-of-School Program

**Week 6 Activity:** Final processing and caption writing **Time:** 25 minutes

### **Procedure**

- Youth take time to finish processing final 1 to 2 images.
- Youth create captions for any images they want to be considered for the final exhibit display.
- Youth can add to captions, based on the answers to questions they had about each image that may have been answered during the field trip.
- If time, youth can use resources to find answers to questions they have raised about their images.

### ***Objective***

To finish all captions for processed images

Kids Capture Their Universe: An Astronomy Out-of-School Program

<p><b>Week 6 Activity: “Best in Show” peer feedback</b> <span style="float: right;"><b>Time: 20 minutes</b></span></p>	
<p><b>Procedure</b></p> <p>PREPARATION (5 minutes)</p> <ul style="list-style-type: none"> <li>• Print out or have each youth display all images for consideration on their computer screen.</li> <li>• Print/write out captions for each image and display it near the image.</li> </ul> <p>VOTING (10 minutes)</p> <ul style="list-style-type: none"> <li>• Youth take a few minutes to wander around the room and mentally identify their favorite image/caption combination created by their peers.</li> <li>• Each youth/facilitator gets 10 or so sticky dots</li> <li>• Youth/facilitator place sticky dots on the labels associated with their favorite images</li> </ul> <p>CHOOSING (10 minutes)</p> <ul style="list-style-type: none"> <li>• Youth return to their image collection and choose their top 2-3 images for the astrophotography exhibit (Sticky dots provide feedback about which images their peers liked best, but the ultimate decision is their own.)</li> <li>• Youth assemble their chosen images and accompanying captions</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To provide positive feedback on youth’s images</p> <p>To choose final images for exhibit displays</p>

**Materials needed:** Sticky dots, pens/pencils, Post-Its

## Kids Capture Their Universe: An Astronomy Out-of-School Program

<b>Week 6 Activity:</b> Develop image exhibit groups		<b>Time:</b> 15 minutes
<b>Procedure</b> <ul style="list-style-type: none"><li>• Youth present each of their chosen images to the group, pointing out important vocabulary that their selections include</li><li>• With input from youth, facilitator presents possible groupings for final exhibit displays, based on the submitted images and range of vocabulary</li><li>• Some ideas for groupings include the following:<ul style="list-style-type: none"><li>○ type of object (solar system, nebulae, galaxies)</li><li>○ color</li><li>○ image processing tool used</li></ul></li><li>• If needed, youth can vote on the final groupings.</li><li>• Note: assigning youth to a particular group happens in week 7, but if there is extra time, facilitators can get a head start on this by soliciting requests/preferences in week 6</li></ul>	<b>Objective</b> <p>To decide the group themes for the exhibits.</p>	

## Week 7 (Creative Element Construction)

**Lesson Objectives: *What do we need to get done today?***

**By the end of the lesson, the youth will:**

1. Complete at least one “creative element” for their exhibit displays, including a caption
2. Create an overall written introduction for their exhibit display

**Learning Objectives: *What will the youth learn today?***

**By the end of the lesson, the youth will have learned:**

1. Organizational skills for sharing work between team members
2. Time management skills for working within a deadline

**Agenda based on the lesson plan. Post in the room for the youth to see.**

- |  |                              |
|--|------------------------------|
| 1. Review Agenda                           | 5 Minutes                    |
| 2. Choose exhibit groups                   | 10 Minutes                   |
| 3. Lighthouse Game (Teambuilding Activity) | 10 Minutes                   |
| 4. “Creative element” construction         | 50 Minutes (including break) |
| 5. Clean up                                | 5 Minutes                    |
| 6. Closing: Lighthouse Awards              | 10 Minutes                   |

**Preparation and Space Set up:**

Post daily agenda, 10-week program outline, and focus vocabulary for youth

Insert processed images and captions chosen for display into the “Images Template” (if desired)

Print out remaining processed images and captions and place them in the appropriate portfolios

**Vocabulary** *What terms or concepts will you introduce in this session? Post these for the youth to see.*

No new vocabulary, but words from past weeks should be posted (they will be helpful in writing captions and/or preparing for next week’s vocabulary competition).

Focus Vocabulary: Moon, planet, star, nebula, galaxy,

Additional Vocabulary: Our Solar System, Milky Way, universe

**Materials and Equipment**

*Physical resources:* Blindfolds, candy, exhibit display boards. craft supplies, youth’s printed-out images and captions for exhibit displays, Astrophotography exhibit Planning checklists, (optional) sample exhibit display created by facilitator to show youth, Astrophotography exhibit Voting slips if not already decided

*Electronic resources:* None, but youth’s images should still be on the computers

*Computing resources:* None, unless text for exhibit display boards is to be typed/printed during the session or additional images need to be processed (software would be needed for this)

**Kids Capture Their Universe: An Astronomy Out-of-School Program**

<p><b>Week 7 Activity:</b> Choose exhibit groups <span style="float: right;"><b>Time:</b> 10 minutes</span></p>	
<p><b>Procedure</b></p> <ul style="list-style-type: none"> <li>• facilitator sets out all color images and associated captions for each of the exhibits, as determined in week 6. In each area, one piece of paper is available</li> <li>• Youth vote on which exhibit “team” they’d like to work.</li> <li>• While facilitators create the final exhibit groups, youth visit every exhibit area and brainstorm ideas for possible “creative” projects that could go with each exhibit area.             <ul style="list-style-type: none"> <li>○ Examples include words for astropoems, sketches for sculptures, or some other idea (flipbook, game, etc.)</li> <li>○ Youth write ideas on a common piece of paper to be left in that area.</li> </ul> </li> <li>• facilitator announces final groups (which then stay together for the light house opening challenge).</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To choose the youth who will work on each exhibit display</p> <p>To allow all youth to have creative input on each exhibit section</p>

**Materials:** All color images and captions, scrap paper

Kids Capture Their Universe: An Astronomy Out-of-School Program

<b>Week 7 Activity:</b> Lighthouse Game (Teambuilding)		<b>Time:</b> 10 minutes
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY</p> <ul style="list-style-type: none"> <li>Set up a short obstacle course of furniture, etc. and positions one facilitator at one end of it, with a few pieces of candy in his or her hand.</li> <li>Blindfold the facilitator with the candy.</li> <li>The blindfolded facilitator is the “ship,” the candy is the “cargo” and the other facilitator is the “lighthouse,” who must guide the ship through the course to deliver the cargo by giving very specific and clear instructions (turn a little bit to your left, take a small step forward, etc.)</li> <li>When the ship makes it through the course without hitting any of the furniture, the lighthouse gets the cargo as a reward for good guidance.</li> </ul> <p>DO THE ACTIVITY</p> <ul style="list-style-type: none"> <li>Youth take turn being ships and lighthouses within their project groups. (For groups of three or more, take turns giving instructions, or have two lighthouses guide the ship through different parts of the obstacle course.)</li> <li>If the ship is guided through the course and manages to deliver its cargo without running into anything, the lighthouse gets to keep the cargo as a reward for good guidance.</li> </ul> <p>DISCUSS THE ACTIVITY</p> <ul style="list-style-type: none"> <li>Astronomers work in teams and must trust each other</li> <li>Each component of the exhibit will require multiple people’s input to be successful and people will have to work on each other’s ideas.</li> </ul>		<p><b>Objective</b></p> <p>To develop trust among peer groups</p> <p>To practice giving clear, specific instructions and explanations</p>

**Materials:** Blindfolds, small pieces of candy

## Kids Capture Their Universe: An Astronomy Out-of-School Program

<b>Week 7 Activity:</b> Creative element construction		<b>Time:</b> 50 minutes (including break)
<p><b>Procedure</b></p> <ul style="list-style-type: none"> <li>• Based on brainstormed ideas contributed for each exhibit display group, youth decide on one or more possible “creative elements” that is inspired by one or more of the images/captions in their display.             <ul style="list-style-type: none"> <li>○ Youth should focus on astropoems and/or astrosculptures, but can decide on other creative expressions like flip-books, games, songs, etc.</li> </ul> </li> <li>• Youth select one or more ideas, and assign team members to construct /create them.</li> <li>• For each “creative element” constructed, youth must write a caption answering the following question: <b>How is this creative element related to the image(s) in your display?</b></li> <li>• For each group’s exhibit, youth must write a “written introduction” about the overall exhibit, answering the following question: <b>What is this exhibit about?</b></li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To complete a creative element to the exhibit, including a caption.</p> <p>To create a “written introduction” for each segment of the exhibit (one per youth group)</p> <p><b>Note:</b> By the end of Week 7, all components of the exhibit displays should be completed!</p> <p>Youth should be sure to point out important vocabulary in their captions</p>	

**Materials:** Construction materials, construction paper for astropoems, “creative element” captions and “written introduction”

<b>Week 7 Activity:</b> Lighthouse Awards (Teambuilding)		<b>Time:</b> 10 minutes
<p><b>Procedure</b></p> <p>This is a closing circle activity</p> <ul style="list-style-type: none"> <li>• Youth give “shout outs” to someone else on their team, praising something that person did to guide/help them with their project</li> <li>• Both youth (the “shouter” and the person he/she recognizes) get a prize</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To recognize team members for their contributions to the group project</p>	

**Materials:** Prizes (candy or paper/sticker stars)

<b>Week 8</b>													
<p><b>Lesson Objectives: <i>What do we need to get done today?</i></b>  <b>By the end of the lesson, the youth will:</b></p> <ol style="list-style-type: none"> <li>1. Complete building their exhibits</li> <li>2. Identify important things to share about their exhibits, based on peer feedback.</li> </ol>													
<p><b>Learning Objectives: <i>What will the youth learn today?</i></b>  <b>By the end of the lesson, the youth will have learned:</b></p> <ol style="list-style-type: none"> <li>1. Organizational and time management skills for group work</li> <li>2. What other people like/want to learn more about in their displays</li> </ol>													
<p><b>Agenda based on the lesson plan. Post in the room for the youth to see.</b></p> <table border="0"> <tr> <td>1. Opening: Review Agenda</td> <td style="text-align: right;">5 Minutes</td> </tr> <tr> <td>2. Vocabulary Review Challenge</td> <td style="text-align: right;">15 Minutes</td> </tr> <tr> <td>3. Construct exhibit</td> <td style="text-align: right;">20 Minutes</td> </tr> <tr> <td>4. BREAK (with clean up)</td> <td style="text-align: right;">10 Minutes</td> </tr> <tr> <td>5. Exhibit Gallery Interviews</td> <td style="text-align: right;">30 Minutes</td> </tr> <tr> <td>6. Closing: Share interesting points about exhibit</td> <td style="text-align: right;">10 Minutes</td> </tr> </table>		1. Opening: Review Agenda	5 Minutes	2. Vocabulary Review Challenge	15 Minutes	3. Construct exhibit	20 Minutes	4. BREAK (with clean up)	10 Minutes	5. Exhibit Gallery Interviews	30 Minutes	6. Closing: Share interesting points about exhibit	10 Minutes
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<p><b>Preparation and Space Set up:</b>                      Post daily agenda and 10-week program overview                      Lay out exhibit displays and unattached materials for each group</p>													
<p><b>Vocabulary</b> <i>What terms or concepts will you introduce in this session? Post these for the youth to see.</i></p> <p>No new vocabulary</p>													
<p><b>Materials and Equipment</b></p> <p><i>Physical resources:</i> All printed images and captions for the display, poems/models created the week before, glue, etc. for final construction of exhibit display</p> <p><i>Electronic resources:</i> Slide show of example “creative presentations” from past programs (or printed photos thereof if a projector/computer is not available)</p> <p><i>Computing resources:</i> None</p>													

Week 8 Activity: Vocabulary Competition		Time: 15 minutes
<p><b>Procedure</b></p> <p>PREPARATION</p> <ul style="list-style-type: none"> <li>• Write each vocabulary word on an index card, shuffle all cards, and put them in a box/hat/bag                             <ul style="list-style-type: none"> <li>○ Telescopes: telescope, aperture, mirror, shutter, detector, image</li> <li>○ Image processing: sharpen, zoom, brightness, contrast, false color table, noise</li> <li>○ Astronomy: Moon, planet, star, nebula, galaxy, universe, Solar System, Milky Way</li> </ul> </li> <li>• Category distinctions can be given as hints, if desired</li> </ul> <p>DO THE ACTIVITY</p> <ul style="list-style-type: none"> <li>• Split the youth into small groups, preferably those in which they will be working on their exhibit displays</li> <li>• Individuals take turns drawing a word from the box/bag/hat and, after consultation with their team, trying to define it</li> <li>• If they get it right (as judged by the CT), they get a point</li> <li>• If they get it wrong the other teams get a chance to “steal” the point by supplying the correct definition</li> <li>• Team with the most points gets a prize</li> <li>• Vocabulary remains posted for the rest of the session (teams may not get through all the words—the facilitator may choose to end the game before all words are defined)</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To review vocabulary from the program</p> <p>To encourage cooperation and conversation within teams</p>	

Kids Capture Their Universe: An Astronomy Out-of-School Program

<p><b>Week 8 Activity:</b> Construct exhibit <span style="float: right;"><b>Time:</b> 20 minutes</span></p>	
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY (facilitator)</p> <ul style="list-style-type: none"> <li>• facilitator arranges several pre-chosen images, captions and self-made creative element into a well-organized “example exhibit.”</li> <li>• Model positive handling of conflicts about “what goes where”, as well as good gluing techniques (i.e. not too much!), and prominent placement of title.</li> <li>• Additionally or alternatively, show physical examples or pictures of previous KCU astrophotography exhibits to spark youth creativity.</li> </ul> <p>DO THE ACTIVITY</p> <ul style="list-style-type: none"> <li>• Youth construct their exhibit, following guidelines demonstrated by facilitator.</li> <li>• Once all components are attached, youth may decorate the displays</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To construct exhibit with good teamwork and cooperation.</p>

## Kids Capture Their Universe: An Astronomy Out-of-School Program

<b>Week 8 Activity:</b> Exhibit Gallery Interviews	<b>Time:</b> 30 minutes
<p><b>Procedure</b></p> <p>All exhibit displays should be fully assembled and displayed around the room before beginning this activity.</p> <p>MODEL THE ACTIVITY (5 minutes)</p> <ul style="list-style-type: none"> <li>• Using the example exhibit they’ve constructed, the facilitators take on the roles of an exhibit designer and exhibit visitor.</li> <li>• Exhibit visitor asks questions, including some of the following:               <ul style="list-style-type: none"> <li>○ How did you get these images? Where did they come from?</li> <li>○ Which is your favorite image, and why?</li> <li>○ How are these images the same and/or different?</li> <li>○ Why did your group choose to make this particular creative element?</li> <li>○ What is different/similar about the objects in these two images?</li> <li>○ Tell me about how this image was created</li> <li>○ What’s the difference between this nebula here, and that galaxy, there?</li> <li>○ What tools did you use to make these two images of the same object look different?</li> <li>○ Show me an interesting detail about that image.</li> </ul> </li> <li>• Exhibit designers use vocabulary correctly to answer questions, and also interviews the visitor, recording answers to the following questions:               <ul style="list-style-type: none"> <li>○ What do you find most interesting about our display?</li> <li>○ What do you want to know more about?</li> </ul> </li> </ul> <p><b>For a more interactive/lively exchange:</b> Youth are rewarded for using vocabulary correctly in both questions and answers. Each time a team uses a vocabulary word correctly, they get a point awarded by facilitator. Team with most points at end gets a reward.</p>	<p style="text-align: center;"><b>Objective</b></p> <p>To experience what it is like for visitors to visit the exhibition.</p> <p>To provide constructive feedback on the information presented in the exhibit displays</p> <p>To come up with a creative way of teaching about the astronomy content in the exhibition</p>

## Kids Capture Their Universe: An Astronomy Out-of-School Program

### DO THE ACTIVITY (20 minutes)

- Pair display groups, along with a facilitator with each pair.
- Begin at one group's display, spending 1-2 minutes silently examining/reading the information presented.
- Exhibit visitors ask questions, with some help from facilitator, if needed.
- The designer group should interview the visiting group, recording answers to questions on the right
- Repeat the above exchange at the other group's display, reversing roles.

### APPLY THE ACTIVITY (5 minutes)

- Based on recorded answers and questions, exhibit design groups record 1 to 2 things they would like to emphasize in their oral presentation. These should be reflective of what the other group found most interesting. These ideas can be shared during closing circle.

**Materials Needed:** Paper and writing utensils for taking notes

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double-sided printing

<b>Week 9</b>								
<p><b>Lesson Objectives: <i>What do we need to get done today?</i></b>  <b>By the end of the lesson, the youth will:</b></p> <ol style="list-style-type: none"> <li>1. Practice giving oral presentations</li> <li>2. Provide feedback to classmates on oral presentations</li> </ol>								
<p><b>Learning Objectives: <i>What will the youth learn today?</i></b>  <b>By the end of the lesson, the youth will have learned:</b></p> <ol style="list-style-type: none"> <li>1. How to give and receive positive and constructive feedback to and from peers</li> <li>2. How to effectively engage audiences with astronomy content</li> </ol>								
<p><b>Agenda based on the lesson plan. Post in the room for the youth to see.</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding-left: 20px;">1. Opening: Review Agenda</td> <td style="text-align: right; padding-right: 20px;">5 Minutes</td> </tr> <tr> <td style="padding-left: 20px;">2. Activity: What makes a good presentation?</td> <td style="text-align: right; padding-right: 20px;">30 Minutes</td> </tr> <tr> <td style="padding-left: 20px;">3. Practice presentations &amp; provide written feedback, including break</td> <td style="text-align: right; padding-right: 20px;">45 Minutes</td> </tr> <tr> <td style="padding-left: 20px;">4. Closing circle</td> <td style="text-align: right; padding-right: 20px;">10 minutes</td> </tr> </table>	1. Opening: Review Agenda	5 Minutes	2. Activity: What makes a good presentation?	30 Minutes	3. Practice presentations & provide written feedback, including break	45 Minutes	4. Closing circle	10 minutes
1. Opening: Review Agenda	5 Minutes							
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4. Closing circle	10 minutes							
<p><b>Preparation and Space Set up:</b>                      Post daily agenda and 10-week program overview                      Make copies of Presentation Feedback form</p>								
<p><b>Vocabulary</b> <i>What terms or concepts will you introduce in this session? Post these for the youth to see.</i></p> <p>No new vocabulary</p>								
<p><b>Materials and Equipment</b></p> <p><i>Physical resources:</i> Completed exhibit displays, Presentation Planning worksheets, Peer Review feedback forms, writing utensils</p> <p><i>Electronic resources:</i></p> <p><i>Computing resources:</i></p>								

Week 9 Activity: What makes a good presentation? Time: 30 minutes	
<p><b>Procedure</b></p> <p>MODEL THE ACTIVITY (15 minutes)</p> <ul style="list-style-type: none"> <li>• Model a “bad” presentation                             <ul style="list-style-type: none"> <li>○ Hard to understand (orally)</li> <li>○ Hard to understand (content-wise, incorrect use of vocabulary)</li> <li>○ Bored/uninterested presenter</li> <li>○ Not paying attention to the audience</li> <li>○ One person dominates and the other does not contribute</li> <li>○ Is not clear when the presentation has ended</li> </ul> </li> <li>• Ask youth what the presenter(s) could have done to improve the presentation</li> <li>• Write the qualities of a good presentation on the board and hand out the “KCU exhibit Criteria for Excellence” review forms, which include the following: teamwork, good explanations (i.e. use of vocab), presentation style.</li> <li>• Facilitator lists possible roles for youth to take, and brainstorm more with youth’s help (see list below)</li> </ul> <p>DO THE ACTIVITY (15 minutes)</p> <ul style="list-style-type: none"> <li>• Youth plan their own presentations, based on what they want to share about their exhibit, and the criteria and roles presented.</li> <li>• Youth can be asked to explicitly select roles, if that works well for your group. (Choose several roles from the list below and create a “sign-up” sheet for each group.)</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To identify the elements of a good presentation</p> <p>To practice presenting</p>

Suggestions for presentation roles are listed on the next page.

### **Suggestion for Youth Roles in the Presentation**

- Welcome people to the exhibit
- Present the overall theme of this panel of the exhibit.
- Point out an image and present the caption to explain WHAT the object is (using vocabulary correctly).
- Point out an image and present the caption to explain HOW the image was processed (using vocabulary correctly.)
- Point out an image and then SHOW how that image was processed by taking a visitor through that process on a nearby computer until the image is exactly like what's on the exhibit. (THIS IS A HUGE WOW FACTOR FOR AUDIENCES!!)
- Help visitors to take their own image on the Guest Observer Portal (Note: computer with internet connection needed in the Astrophotography exhibit space)
- Define an important vocabulary word (for example, if all exhibit pictures are galaxies, explain what a galaxy is)
- Define an important processing tool and explain what it does, using example images, if possible
- Show a processing tool on a nearby computer.
- Present the "creative element" (read poem or point out features of sculpture/model) and explain which images inspired its creation.
- Explain why two images of the SAME object look different.
- Tell about what happened during the program over the past 10 weeks using parts of your exhibit as visual aids
- Describe the field trip and do a teachback about what you learned there.
- Tell about your most and least favorite part of the program and WHY.
- Create a kinesthetic model as a group, with one or more narrators (e.g. telescope or lifecycle of a star)
- Explain what a telescope does, if there are exhibit images to support that explanation.
- Explain how astronomers use color when displaying images.
- Point out features of an image while a teammate talks about it.
- Explain why they organized the display the way they did.
- Thank visitors for coming to your exhibit.
- Anything else that your group wants to share about the exhibit or the program!

Kids Capture Their Universe: An Astronomy Out-of-School Program

<p><b>Week 9 Activity:</b> Practice presentations with written feedback      <b>Time:</b> 40 minutes</p>	
<p><b>Procedure</b></p> <ul style="list-style-type: none"> <li>• Youth present to at least one other group, if not the whole class.</li> <li>• Class gives oral and/or written feedback on the presentation, based on the criteria for excellence:</li> </ul> <p><b>TEAMWORK</b></p> <ul style="list-style-type: none"> <li>○ Good transitions between youth</li> <li>○ Each youth has a role in the presentation</li> <li>○ Youth give credit to the work done by others</li> </ul> <p><b>GOOD EXPLANATIONS</b></p> <ul style="list-style-type: none"> <li>○ Includes astronomy vocabulary, used correctly</li> <li>○ Includes image processing vocabulary, used correctly</li> <li>○ Youth use descriptive words in place of “it”, “this”, “thing”, etc</li> </ul> <p><b>PRESENTATION STYLE</b></p> <ul style="list-style-type: none"> <li>○ Youth point to features of visual aid (image, model, etc.) when talking about them</li> <li>○ Youth make eye contact</li> <li>○ Youth speak slowly, loudly and clearly Not paying attention to the audience</li> </ul> <ul style="list-style-type: none"> <li>• If time, youth present again, incorporating that feedback.</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To practice presenting</p>

**Materials needed:** writing utensils and peer review feedback forms (Page 86)

<b>Week 10 (Final Preparation for the astrophotography exhibit)</b>												
<p><b>Lesson Objectives: <i>What do we need to get done today?</i></b>  <b>By the end of the lesson, the youth will:</b></p> <ol style="list-style-type: none"> <li>1. Practice presenting twice</li> <li>2. Choose a peer representative to represent their program at the astrophotography exhibit.</li> </ol>												
<p><b>Learning Objectives: <i>What will the youth learn today?</i></b>  <b>By the end of the lesson, the youth will have learned:</b></p> <ol style="list-style-type: none"> <li>1. How to give effective presentations in front of an audience</li> </ol>												
<p><b>Agenda based on the lesson plan. Post in the room for the youth to see.</b></p> <table border="0"> <tr> <td>1. Opening: Survey</td> <td>5 Minutes</td> </tr> <tr> <td>2. Make final changes to exhibit displays, if necessary</td> <td>15 Minutes</td> </tr> <tr> <td>3. BREAK (can occur between rounds of Astronomy Idol)</td> <td>5 Minutes</td> </tr> <tr> <td>4. Icebreaker: Color-Passing Challenge</td> <td>10 Minutes</td> </tr> <tr> <td>5. Challenge: Astronomy Idol</td> <td>45 Minutes</td> </tr> <tr> <td>6. Closing: Prepare for astrophotography exhibit</td> <td>10 Minutes</td> </tr> </table>	1. Opening: Survey	5 Minutes	2. Make final changes to exhibit displays, if necessary	15 Minutes	3. BREAK (can occur between rounds of Astronomy Idol)	5 Minutes	4. Icebreaker: Color-Passing Challenge	10 Minutes	5. Challenge: Astronomy Idol	45 Minutes	6. Closing: Prepare for astrophotography exhibit	10 Minutes
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5. Challenge: Astronomy Idol	45 Minutes											
6. Closing: Prepare for astrophotography exhibit	10 Minutes											
<p><b>Preparation and Space Set up:</b>                      Post daily agenda and 10-week program overview                      Make additional copies of Presentation Feedback forms if necessary                      Choose space for Astronomy Idol (auditorium, cafeteria, etc.), set up working spaces for each exhibit display group, if necessary</p>												
<p><b>Vocabulary</b> <i>What terms or concepts will you introduce in this session? Post these for the youth to see.</i></p> <p>N/A</p>												
<p><b>Materials and Equipment</b></p> <p><i>Physical resources:</i> Exhibit displays, glue, markers, and (minimal) craft supplies, prize for Astronomy Idol, presentation feedback forms</p> <p><i>Electronic resources:</i> Images for processing demonstrations, if necessary</p> <p><i>Computing resources:</i> Image processing software, if necessary</p>												

<p><b>Week 10 Activity:</b> Color Passing (Skill building) <span style="float: right;"><b>Time:</b> 10 minutes</span></p>	
<p><b>Procedure</b></p> <p>DEMONSTRATE THE PURPOSE OF THE ACTIVITY</p> <ul style="list-style-type: none"> <li>• Start by shouting the explanation loudly and incoherently; then, slow down and repeat what you said so youth can understand you</li> <li>• Explain If you do not speak clearly, no one will understand what you are saying</li> <li>• In large rooms, voices tend to echo, which makes it hard to understand what someone is saying</li> <li>• Speak slowly and loudly, but do not shout</li> <li>• Take breaks between thoughts of a sentence so the audience can have time to absorb and process the information you are giving</li> </ul> <p>MODEL AND DO THE ACTIVITY</p> <ul style="list-style-type: none"> <li>• Everyone stands around the edged of a large (echoy) space, as far away as other people as possible</li> <li>• One facilitator models the activity by “passing” to another facilitator: “My name is TEACHER and I pass BLUE to LEADER”</li> <li>• The second facilitator models the activity by “catching” the color, and saying “BLUE!”</li> <li>• The second facilitator passes a new color to someone else in the room</li> <li>• Continue passing and catching colors (or other silly words) around the room</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To practice speaking slowly, loudly, and clearly</p>

Kids Capture Their Universe: An Astronomy Out-of-School Program

<b>Week 10 Activity:</b> Astronomy Idol		<b>Time:</b> 45 minutes
<p><b>Procedure</b></p> <p>Facilitator acts as emcee for the competition</p> <p>ROUND 1 (15 minutes)</p> <ul style="list-style-type: none"> <li>• Each group presents their exhibit/demonstration to their peers.</li> <li>• Other groups evaluate the presentations, using the feedback form provided by the facilitator</li> <li>• After each group has presented, the other groups provide oral feedback (one positive response, one suggestion for improvement) based on their written forms</li> </ul> <p>ROUND 2 (15 minutes)</p> <ul style="list-style-type: none"> <li>• Each group presents again, taking into account the feedback they have received</li> <li>• After all groups have presented, all individuals vote anonymously on which presentation was most effective and engaging.</li> <li>• Facilitator tallies the votes (including their own) and gives a prize to the most deserving Astronomy Idol.</li> </ul>		<p><b>Objective</b></p> <p>To practice presenting astronomy content to an audience</p> <p>To provide feedback on youth’s presentations</p>

**Materials:** Pens/pencils, feedback forms, clipboards/notebooks to write on, prize for winner of the competition

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double-sided printing

<b>Week 11 (Optional Reflection)</b>							
<p><b>Lesson Objectives: <i>What do we need to get done today?</i></b>  <b>By the end of the lesson, the youth will:</b></p> <ol style="list-style-type: none"> <li>1. Reflect on the program and the Astrophotography exhibit events</li> </ol>							
<p><b>Learning Objectives: <i>What will the youth learn today?</i></b>  <b>By the end of the lesson, the youth will have learned:</b></p> <ol style="list-style-type: none"> <li>1. N/A</li> </ol>							
<p><b>Agenda based on the lesson plan. Post in the room for the youth to see.</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;">1. Post-program survey</td> <td style="width: 20%; text-align: right;">10 Minutes</td> </tr> <tr> <td>2. KCU Focus Group</td> <td style="text-align: right;">15 Minutes</td> </tr> <tr> <td>3. Some game of youth's choice</td> <td style="text-align: right;">Remaining Minutes</td> </tr> </table>		1. Post-program survey	10 Minutes	2. KCU Focus Group	15 Minutes	3. Some game of youth's choice	Remaining Minutes
1. Post-program survey	10 Minutes						
2. KCU Focus Group	15 Minutes						
3. Some game of youth's choice	Remaining Minutes						
<p><b>Preparation and Space Set up:</b>                      Set up feedback questions as stations around the room                      Set up circle of chairs for group discussion/focus group</p>							
<p><b>Vocabulary</b> <i>What terms or concepts will you introduce in this session? Post these for the youth to see.</i></p> <p>N/A</p>							
<p><b>Materials and Equipment</b></p> <p><i>Physical resources:</i> Method for recording youth's reflections</p> <p><i>Electronic resources:</i> N/A</p> <p><i>Computing resources:</i> N/A</p>							

## Kids Capture Their Universe: An Astronomy Out-of-School Program

<b>Activity:</b> KCU Focus Group <span style="float: right;"><b>Time:</b> 15 minutes</span>	
<p><b>Procedure</b></p> <ul style="list-style-type: none"> <li>• After giving youth the post-program survey, have them sit in a circle to reflect on and discuss their experience during the program.</li> <li>• It may be advantageous to have youth think quietly or jot down ideas about a question before discussing it with the whole group, to give them time to develop meaningful contributions. Alternatively, they could even discuss different questions in subdivided groups.</li> <li>• The goal here is to give youth a chance to see how far they've come in 10 weeks, as well as give the facilitator some feedback, if they'd like to run the program again. (And we hope you do!)</li> </ul> <p>Possible questions / reflections to bring up:</p> <ul style="list-style-type: none"> <li>• Have youth remind each other what happened during each week of the program, using the 10 week outline plan as a visual guide.</li> <li>• What was your most favorite thing about the program?</li> <li>• What was your least favorite thing about the program?</li> <li>• What was the funniest thing that happened?</li> <li>• What was the most important thing you got out of being a participant this semester?</li> <li>• If you were teaching the program, what would you do differently?</li> <li>• What would you tell other kids about this program, if you were advertising it?</li> <li>• What do you feel most proud of about your astrophotography exhibits?</li> <li>• What was the best part about participating in the Astrophotography exhibit?</li> <li>• How do you think you are different now than on day one of the program?</li> <li>• Is this what you thought "doing science" would be like?</li> <li>• How was the program different from what you expected?</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>To reflect on their experience and give feedback to the facilitator</p>

## Supplemental Activities

Supplemental Activity: Making Images With Mirrors		Time: 10 minutes
<p><b>Procedure</b></p> <p>PREPARE THE ACTIVITY</p> <ul style="list-style-type: none"><li>• Set up a bright light bulb or other source at one side of a room or hallway (this activity can be done outside if a plug is available). If no light bulb is available, this activity will sometimes work with a day-lit window in a darkened room</li><li>• Test the activity before doing it with youth—if the conditions are not right, the activity will not serve any purpose except to frustrate the youth!</li><li>• Use the template on page E-2 in the curriculum to cut out the aperture on the aperture/detector worksheet. Use a piece of scrap paper or cardboard as the shutter</li><li>• Make enough of each page (aperture/detector &amp; shutter) for each pair of youth.</li></ul> <p>DO THE ACTIVITY</p> <ul style="list-style-type: none"><li>• Give each pair of youth a concave mirror, such as cosmetic mirrors found in a traditional drug store, a shutter page, and an aperture/detector page.</li><li>• Their challenge is to focus the light from the light source to create an image of the light source on the detector.</li></ul> <p>DISCUSS THE ACTIVITY</p> <ul style="list-style-type: none"><li>• Can they explain how they made their image? What does the shutter do? What is the path of the light?</li></ul>	<p><b>Objective</b></p> <p>To learn how light travels through a telescope and how astronomical images are made</p>	

**Materials Needed:** Pre-made aperture/detector pages, pre-labeled shutter pages, concave mirrors, bright light bulb or other detectable light source

<p><b>Supplemental Activity/Discussion:</b> Images from telescopes    <b>Time: 10 minutes</b></p>	
<p>This activity is more of a discussion than a processing challenge, but it is done around a computer.</p> <ul style="list-style-type: none"> <li>• Open MicroObservatoryImage from shortcut on desktop.</li> </ul> <p>OBSERVATION (5 minutes)</p> <ul style="list-style-type: none"> <li>• Open the image of the Prudential tower captured WITHOUT a telescope</li> <li>• Explain that this is a digital image taken with an ordinary digital camera from the roof of the Harvard Observatory, where MicroObservatory telescopes are located.</li> <li>• Ask youth how they would describe the tower just from looking at the non-telescope image</li> <li>• Record (or have youth record) their observations</li> <li>• Open the image of the Prudential tower captured WITH a telescope, explaining that it was taken from the same location, but with a telescope</li> <li>• Ask youth how they would describe the tower just from looking at the telescope images</li> <li>• Record (or have youth record) their observations.</li> <li>• Optional: Youth can create a caption to describe the two views/images.</li> </ul> <p>DISCUSSION (5 minutes)</p> <ul style="list-style-type: none"> <li>• Why use telescopes? What do telescopes do?             <ul style="list-style-type: none"> <li>○ Make a far-away object appear closer</li> <li>○ Show more detail in/on an object</li> <li>○ Collect more light (objects appear brighter, but this is not shown by observing the images of the Prudential Center)</li> </ul> </li> <li>• Optional: Zoom in on the tower in the non-telescope image so that it shows the same field of view as the telescope image...do they look the same now?</li> </ul>	<p style="text-align: center;"><b>Objective</b></p> <p>Model how to open images using MicroObservatoryImage</p> <p>Learn what a telescope does:</p> <ul style="list-style-type: none"> <li>• Makes far-away objects appear closer</li> <li>• Shows more detail about objects</li> <li>• Collects (more) light (than can be collected without a telescope)</li> </ul> <p>(Optional) Model the use of the Zoom tool.</p>
<p><b>Supplemental Processing Challenge:</b> Color Tables    <b>Time: 10 minutes</b></p>	

Each computer station should be assigned a different color table, either by random assignment or by having youth drawing the color table names out of a hat.

1. Write the name of the color table at the top of the page and create a 3x3 chart below it, labeling the rows and columns as in the examples to the left.
2. Open an already-processed image such as Tower2
3. The facilitator first models the activity using the Gray Scale color table
4. Apply the assigned/chosen color table to an already-processed image by choosing “Process” > “Color Table” > “Gray Scale” (or “Red” or “Spectrum,” etc.)
5. Fill in the second line of the chart by observing which colors represent the highest, lowest, and in-between pixel values in the image.
6. Save the image as a GIF with a descriptive name
7. Re-open the image and apply the assigned color table, then choose “Process” > “Invert Color”
8. Fill in the third line of the chart for the new appearance
9. Save the new image as a GIF with a different name

**REFLECTION**

1. Open both images so they are visible on the screen
2. Walk around the room and look at all the images that have been created. After observing them all, each youth stands next to his or her favorite view
3. Each person/group must come up with a reason why they chose that image as their favorite and share it with the group (beyond “I like the color”)

**Objective**

Apply color tables to change the appearance of an image

Articulate your personal connection to an image

Color Table: Gray Scale

	High Pixel Values	Pixel Values In Between	Low Pixel Values
False Color	<i>White</i>	<i>Light gray</i> <i>Dark gray</i>	<i>Black</i>
Inverted	<i>Black</i>	<i>Dark gray</i> <i>Light gray</i>	<i>White</i>

Color Table: Blue

	High Pixel Values	Pixel Values In Between	Low Pixel Values
False Color	<i>Bright blue</i>	<i>Royal blue</i> <i>Navy blue</i>	<i>Black</i>
Inverted	<i>Black</i>	<i>Royal blue</i> <i>Navy blue</i>	<i>Bright blue</i>

Example Color Table: Fire

	High Pixel Values	Pixel Values In Between	Low Pixel Values
False Color	<i>White</i>	<i>Yellow</i> <i>Orange</i> <i>Red</i> <i>Purple</i> <i>Blue</i>	<i>Black</i>
Inverted	<i>Black</i>	<i>Blue</i> <i>Turquoise</i> <i>Green</i> <i>Yellow</i>	<i>White</i>

Other color tables:  
Red, Green, Spectrum, Ice

**Prompts:** What is it about this color choice that you like? What features of the image stand out? Does it remind you of anything?

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double-sided printing

## **Worksheets and Templates**

### Useful Tools for Running the Program

#### **Pre/Post Program Survey**

Assessment tool for Weeks 1 and Week 10 or 11

#### **Observing Logs**

For keeping track of telescope requests—can be recorded by individual youth, or a collectively across the whole group

#### **Image Processing Log**

For youth to keep track of the images they save and create good captions to accompany the saved images

#### **Checklist for Astrophotography exhibit**

Youth-friendly requirements for the exhibit displays

#### **Oral Presentation Planning**

For figuring out which topics and images will be included in each group's oral presentation, and who will present each part

#### **Presentation Feedback Form**

Peer review criteria for practicing and improving presentations

#### **Image Display Template**

Model of how facilitator can consolidate final images and captions for the exhibit displays (color printer recommended)

#### **Group Preference Forms**

A strategy for taking youth preference into account when choosing who will work on which exhibit displays

# Kids Capture Their Universe Program Survey

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What is your favorite...  
School subject: \_\_\_\_\_ Music: \_\_\_\_\_  
Hobby: \_\_\_\_\_ Sport: \_\_\_\_\_  
Food: \_\_\_\_\_

2. Imagine this: You are about to stand up in front of 20 classmates and talk for a couple of minutes about a project you completed.

On a scale of 1 (=really **un**comfortable) to 5 (= really comfortable), rate how you would feel at that moment: \_\_\_\_\_

3. On a scale of 1 (= "I really **DON**"T think this") to 5 (= "I really **DO** think this"), rate how you feel about each of these statements:

I am happy that I am in the KCU program. \_\_\_\_\_

It is possible for **everyone** to be important in a group science project. \_\_\_\_\_

Accepting feedback from my classmates is important to me. \_\_\_\_\_

4. What are words you'd use to describe or tell about this object?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



CONTINUED ON NEXT PAGE!!!

# Kids Capture Their Universe: An Astronomy Out-of-School Program

5. Circle the single best answer for this question:

Our solar system contains:

- a. One average star
- b. Several stars spread across space
- c. One older, dimmer star, and one younger, brighter star
- d. Three stars
- e. No stars

6. Circle all the words that YOU think of when you think about **doing science.**

working alone	hard	important to me	easy
creative	understandable	group work	interesting
boring	fun	scary	

6. Write down questions you have about astronomy, outer space and the universe:

7. Describe what is different about these two images:

---

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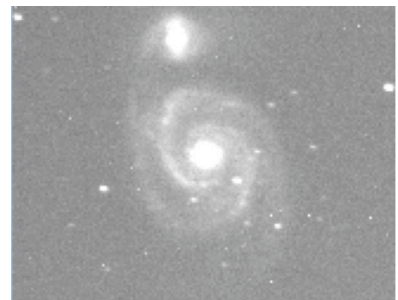
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## Group Observing Log (Alternative to Individual Logs)

Create a master version of this chart and display it publicly to fill out each week.

Object Type	Object Name (e.g. Moon, M101)	Taken By (Youth Names)	Date Requested	Mark when processed
<b>In Our Solar System</b>				
<b>Stars and Clusters of Stars</b>				
<b>Nebulas</b>				
<b>Galaxies</b>				



## Astrophotography Exhibit Checklist

Your astrophotography exhibit is made up of several displays. Each display in your exhibit must have the following parts:

Display Name/Title: \_\_\_\_\_

Names of People Working on this Display

Write them here:

Processed MicroObservatory images

Captions for the MicroObservatory images

Creative element for the display

\_\_\_ Sculpture      \_\_\_ Poem      \_\_\_ Other

Caption for the creative element

How does this element relate to the image(s) in your display?

(Write your caption on a separate page)

Written introduction to the WHOLE Display

What is this display about?

(Write your explanation on a separate page)

## Kids Capture the Universe: Oral Presentation Planning

GROUP/EXHIBIT NAME: \_\_\_\_\_

You will be presenting your astrophotography exhibit. Don't forget to:

- Welcome your visitors and introduce yourselves.
- Tell the story of your display—the theme, organization, and inspiration. Don't forget to include the important astronomy information!
- Tell the story of your creative element—what you made and why you made it. (You can use the information in your caption to help you.)
- Highlight some of the images in the display (not just your own!) and teach back about them in some creative way.
- Thank your visitors for coming and invite them to explore the display.

### Who will do what for your oral presentation?

Role or Responsibility	Who Will Do This?

## Astrophotography Exhibit Peer Review

Exhibit Name: \_\_\_\_\_

Presenters' Names: \_\_\_\_\_

**Check the box you think indicates how well this group did with each guideline:**

Criteria for Excellence	Did great!	Did okay	Needs improvement
<b>Teamwork:</b> <ul style="list-style-type: none"> <li>• Each person has a role in the presentation</li> <li>• Presenters give credit to the work done by others</li> <li>• Good transitions between presenters</li> </ul>			
<b>Good Explanations:</b> <ul style="list-style-type: none"> <li>• Includes astronomy vocabulary, used correctly</li> <li>• Includes image processing vocabulary, used correctly</li> <li>• Presenters use descriptive words in place of "it", "this", "thing", etc.</li> </ul>			
<b>Presentation style:</b> <ul style="list-style-type: none"> <li>• Presenters point to features of visual aid (image, model, etc.) when talking about them</li> <li>• Presenters make eye contact</li> <li>• Presenters speak slowly, loudly and clearly</li> </ul>			

One thing I **liked** about this group's exhibit and presentation is...

One thing this group **could improve** about their exhibit and presentation is...

## Template for Collating Images and Captions for the Astrophotography exhibit!

Ideally, youth will write or type up their own captions. This is a template that youth or facilitators can use to combine the digital GIF files from the youth's computers and the caption information from the processing logs of chosen images. Example pages follow this template.

Delete the text and insert saved GIF image here

If a youth has saved an un-zoomed image, but wants to display it in a zoomed format (e.g. a Moon crater), you must:

Crop the image around the zoomed area.

Enlarge the cropped image so it is roughly the same size as the other images in the exhibit. (Example images are both zoomed.)

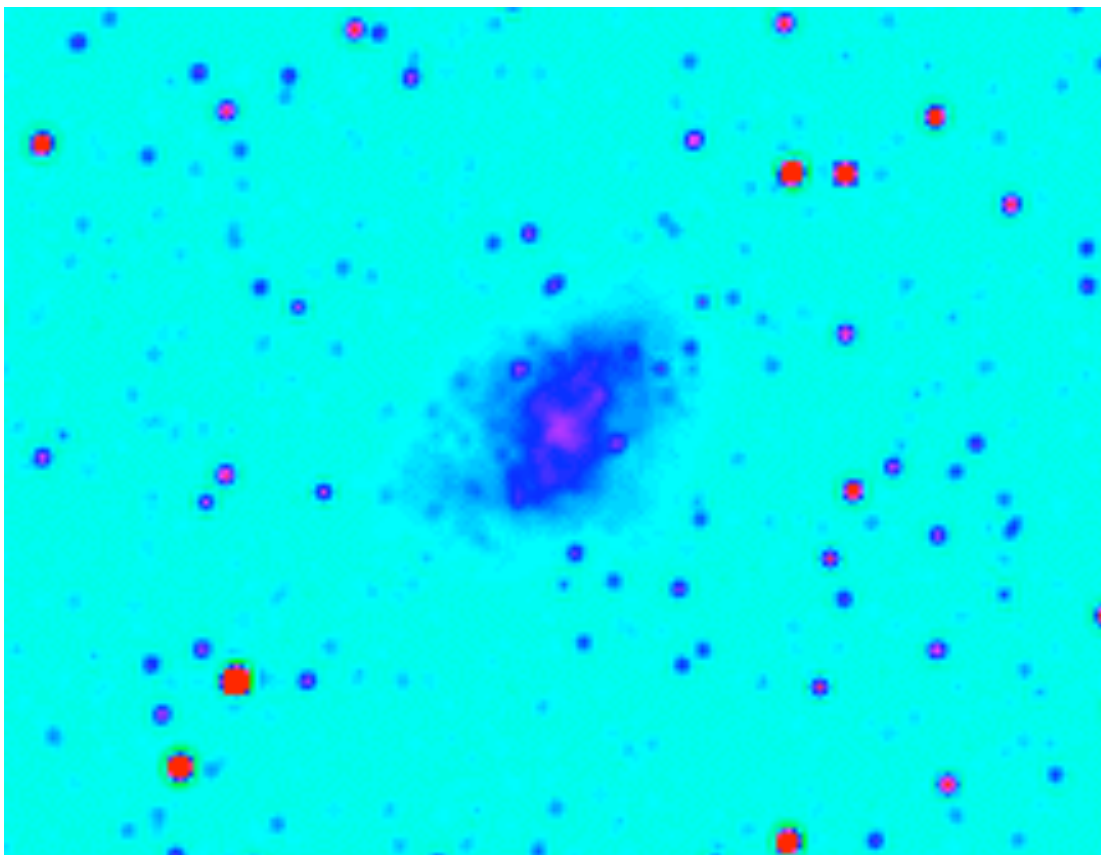
One image/caption pair per page is a good model. In the event that a youth wishes to pair two images (to show an image before and after processing, for example), the layout can, of course, be adjusted. This template is meant as a guide only!

Title of image goes here (if available)

Created by  
Youth(s) name(s) here

Type caption here (from youth's processing logs)

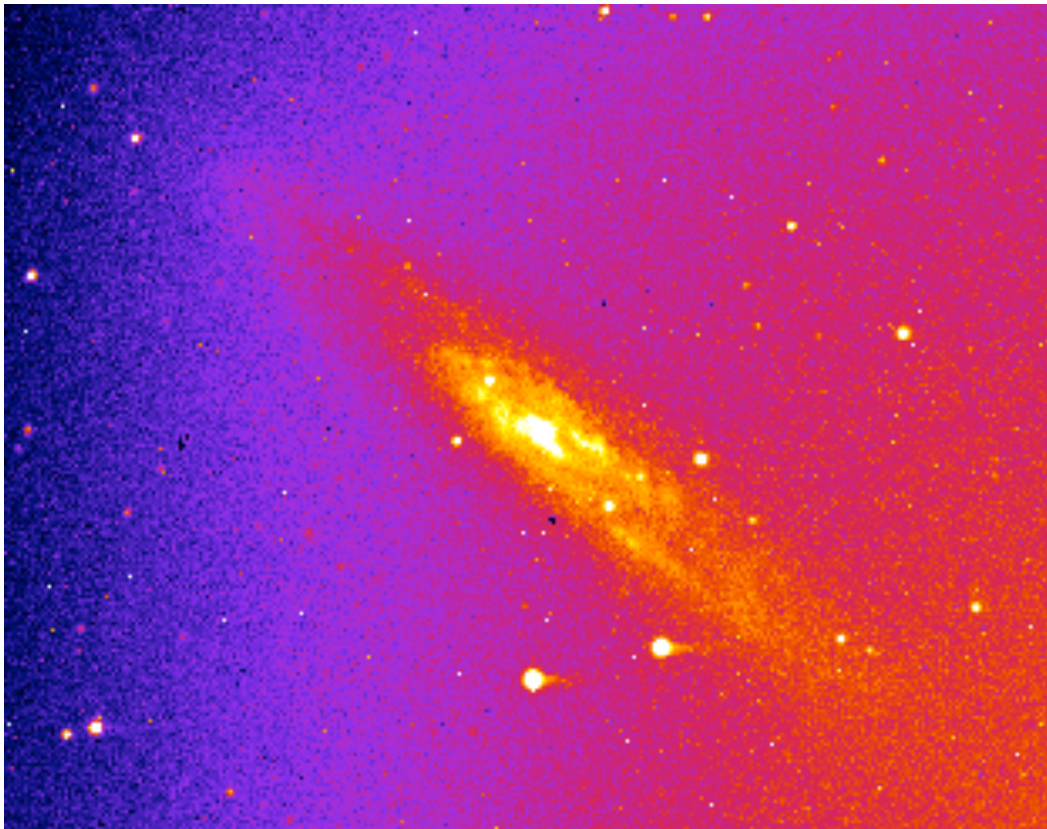
*Print the images and captions on a color printer and distribute the appropriate pages to each group with a glue stick. They can cut or decorate the pages as they like to create their exhibit display. Copy this template into a separate document to remove header/footer.*



## Crab Nebula

By Ashley

This is a dying star.  
It looks like a bird's wing.  
To make my processed image:  
Press "Auto" and change the  
color table to Spectrum.



## **NGC 253 (Galaxy)**

By Duncan

A galaxy is made out of billions of stars.  
This is the NGC 253 galaxy. It is bright enough  
to see from far away. It looks like a spinning top.  
Our galaxy might look exactly like this.

To make my processed image, I opened it, then I  
changed the brightness and the contrast, then  
zoomed in three times and changed the color.

### Group Preference (Request) Forms

Use this template to help youth choose the groups they will be working in for the final exhibit displays. You can make copies of this form as-is and distribute the slips with a master “reference guide” to the exhibit display topics (e.g. 1 = Galaxies, 2 = Orion Nebula, etc. posted on a wall), or you can modify the document to include exhibit display names on the request slips.

---

Your Name: \_\_\_\_\_

Put a “1” next to the display you would be most excited to work on. Put a “2” next to your second choice and a “3” by your third choice.

\_\_\_ Display 1      \_\_\_ Display 2      \_\_\_ Display 3

---

Your Name: \_\_\_\_\_

Put a “1” next to the display you would be most excited to work on. Put a “2” next to your second choice and a “3” by your third choice.

\_\_\_ Display 1      \_\_\_ Display 2      \_\_\_ Display 3

---

Your Name: \_\_\_\_\_

Put a “1” next to the display you would be most excited to work on. Put a “2” next to your second choice and a “3” by your third choice.

\_\_\_ Display 1      \_\_\_ Display 2      \_\_\_ Display 3

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