

Section 2: Parts K-R (Notes and Journal Answers)

Connecting Matrices and the Afterglow Access Tools

Part K - Connecting Matrices and the Afterglow Access Tools

A) BRIGHTNESS AND CONTRAST

1. *The Display Settings panel lists **Brightness and Contrast Presets** at the top. Under these is the histogram. Under that is **Brightness and Contrast Settings**.*
 - a. *The students should start with the Jupiter image and explore the presets buttons. They can try other images from the sample file if desired. They should notice how things change on the graph, the image, AND the Percentile numbers under the **Brightness and Contrast Settings**.*
 - i. *Recall the histogram has the “counts” on the x-axis, and the number of pixels with those counts on the y-axis.*
 - b. *Give the students a chance to play with the numbers. What is the difference between 100% saturation and 100% background level?*
 - i. *Note: The telescopes we are using use a “16 bit” camera. This means the information stored in each pixel can have $2^{16} = 65,536$ different values, in this case, “counts”, or brightness value. The counting of the value starts at zero and goes to 65,535. That gives 65,536 values. (It is similar to why 0 to 9 is ten numbers.)*
 - ii. *On the SJS site this explanation is given:*
 - iii. *Computer screens can only display values for red, green, and blue which range from 0 to 255 (8-bit integers = 2^8). We need to convert the CCD pixel values from 16-bit integers to 8-bit RGB integers. We do this by choosing a pixel value in the CCD image which we will set to black (RGB = 0, 0, 0) and choosing a pixel value in the CCD image which we set to white (255, 255, 255).*
 - iv. *This is where the percentiles for background level and saturation level comes in. The algorithm actually uses the histogram for this. The values on the x-axis are the pixel values recorded by the camera (anywhere from 0 to 65,535), and the value on the y-axis is the number of pixels with that value. The curve plotted is used to set the “black” and “white” values, as explained next:*
 - v. *If you march along the curve starting from the far left, the red vertical line is set at the point where 10% of the pixel values are to the left. Those are then made black, thus, the Background Level Percentile is 10%(Default). Continue to march along the curve. When the point where 99% of the pixel values are to the left, a red vertical line is set. This is the Saturation Level*

Percentile(99% is the Default). All pixels to the right are made white.

- vi. *Every value in between is a shade of gray. Again, these two values are the defaults, and can be changed. The Defaults can be returned to by using the top middle button above the graph.*

NOTE: *The Sonifier Settings mode does not detect the background, or any changes you make in the background level, at this time. It does respond to any zooming that is done in the viewport.*

2. ACTIVITY for Background level:

Chris does a nice job in the video discussing the difference between background level and noise. Background level is usually identifiable as a source of “extra” light - like the moon, clouds, reflections in the telescope, etc. Noise is just attributed to photons that can’t be accounted for. The activity with the radio does a nice job of showing this. Any radio that has an antenna can be used for this activity.

a) What do you think is causing the background radio sound?

b) What do you think is causing the background light found on an astronomical image?

c.) Thought experiment: What if you took the radio to a place where there was no interference? Do you think you would still hear some crackles or buzz?

a)The background radio noise is from all external electric sources in the area. It picks up the EM waves produced by electric outlets, overhead lights, etc.

b)background light is any reflection or stray light from other sources.

c)You would still hear some crackling because of the internal electronics - this is “noise”.

d) Which of these, the background level or saturation level, correspond to a large number of pixels with a small number of counts (or values)?

e) Which of these, the background level or saturation level, correspond to a small number of pixels with large counts (values)?

d)The large number of pixels with a small number of counts is the background level. This should make sense to them - most pixels have a little bit of something they detect - like the background radio light.

e) The brighter objects in the image have large counts but in a small number of pixels - this is saturation level - the pixels with the highest level of counts

B) COUNTS

Before examining an image, have the students recall the word “counts”. Remind them it is the number of electrons the photons of light knock off the detector in each pixel. (It is

recorded as a voltage, but referred to as counts.) Sometimes it is called the brightness level since the more counts the brighter the object is in that pixel.

f) Where are the counts (pixel values) displayed in AgA? (Hint: It is not labeled, and there are at least two places) Record your answer in the JOURNAL.

g) What corresponds to counts on the CCD poster used earlier?

f) The counts are displayed below the image to the right, along with the pixel x-y position. The counts are also displayed on the x axis of the histogram.

g) The white map pins were the counts on the CCD posters.

C) COLOR MAP

1. Recall the CCD poster activity at the very beginning of this Exploration. Why did we have four posters?

2. What filter we have been using for image requests?

a) If your images were not taken with a color filter, how could AgA display color images?

b) Play with the Color Map settings and the image you have in the viewer panel. Record your favorite Color Map setting.

JOURNAL ANSWERS:

- 1. We had four CCD posters to represent four filters. Each filter allowed only the photons of that filter's "range" through. The white pins reflected how many of each color got through to each poster. A colored image is made by assigning the photons counted in each filtered image and assigning to them the color desired. Then the images are added together to make the beautiful colored images we usually see from astronomy.*
- 2. For our purposes, we have been using a "clear" filter. This collects most of the photons in the visible spectrum, and does NOT distinguish between colors. Refer back to Section 1/Part M filter setting for more information.*
 - a. AgA displays colored images by assigning colors to different levels of brightness or counts. It has nothing to do with the "real" color of the object, or the color of the photons collected.*
 - b. Have fun!*

Part L - Manipulation of Matrices 1

This is a link to the list of matrix commands - you might want to run off copies for the students.

[List of Quorum Commands for Matrices](#)

1. ACTIVITY: IMAGE ORIENTATION (Hands-on)

A link to the resource for the activity, which uses the "L" shape mounted on a piece of wood: (Use sleep masks while doing the activity)

[Image Orientation Activities](#)

2. ACTIVITY: MATRIX MANIPULATION (Quorum commands)

A) ADD single value

B) SUBTRACT, MULTIPLY, DIVIDE by a single value

C) COMBINING TWO MATRICES

Several very short videos by Chris within this part help in understanding the concepts. The text file helps in any copying and pasting needed for the commands.

It is helpful to ask for the students to predict what the matrices might look like before they output them. Really encourage them to do that! It helps with computational thinking skills.

Encourage and give praise for all the typing and correct outputs produced!

Part M - Manipulating Matrices 2

This part shows the commands for changing the orientation of a matrix. Try to point out where it relates to Afterglow Access - this relation is discussed on the SJS portal. These are the commands:

1. SHIFT

Compare the two matrices. Did it do what you imagined? Comment in the JOURNAL.

Have a discussion!

2. FLIP

Examine the new matrix. How is it different from the vertical flip? Also relate it to the wooden "L". Can you show each other the "L" flipped vertically and horizontally? Are you correct? Record in the journal.

The physical nature of flipping the "L" really helps. Sleep masks might make it more fun! Record in the Journal.

3. RESHAPE**4. TRANSPOSE**

What do you think happens here?

Examine the new matrix. Describe what took place.

They may need help with the definition of transpose. Chris does give this definition in the video.

5. ROTATE

How many degrees does a 'rotate' mean? Try it and enter your answer into the journal.

Again, try to have the students predict the outcomes of the commands first.

Part N - Field of View

1. FIELD OF VIEW

The whole point of this activity is to discover how small of an area of the sky the telescope sees. The hand exercises can be fun(remember to use an outstretched arm)

Your index finger = one degree

Your fist = 10 degrees

Your spread out fingers, from thumb to pinky finger = 20 degrees

Your pinky finger is about ½ degree, 30 arc minutes.

Actually have them go outside at some point and use this method to see how much of the sky the moon takes up.

Any tactile material can be used on the inside of the umbrella for field of view - just make it the appropriate size using the index finger and pinky finger.

2. IDATA TELESCOPE MIRRORS

This part is mostly information. BUT, if the students find it helpful to have the mirror size drawn out, do so! You may want to ask: "How can the mirror size be so big and the field of view on the sky be so small?". It's all about collecting the light.

There is a formula for finding the field of view for a telescope - it involves the size of the sensor (CCD) chip and the focal length of the telescope. Anyone interested can look up the formula and calculate the field of view for any known telescope and its CCD sensor.

Part O: Finding an Asteroid in your Image

KLEOPATRA

Be sure to have the students open the first Kleopatra image. Later they will open the last image.

1. On your first look at the image, can you find the asteroid? Was it easy or hard?

2. Brainstorm as a group for at least three ideas on how to find the asteroid.

3. How does sonification work on an asteroid image? Describe in detail.

1. *Both sighted and BVI may not be able to find the asteroid at all! Using only one image is difficult if they do not know its position!*
2. *These ideas may include using more than one image, knowing the position of the asteroid at the date and time of image.*
3. *Does it work? Can it find the asteroid? What does the image sound like? Do different settings work?*

Part P - Two Images

1. TWO IMAGES

There are several galaxy images in the IDATA folder. We will be using the M83 ones. There are also two Jupiter images that could work - one in the IDATA folder and the other in the Winston Salem Teacher Workshop.

2. ADDING TWO IMAGES

a) Why do you think an astronomer would want to add two images together?

- Relate this to a pair of alike sounds. (Use a tone app on your phone if you would like).

- Would there be any reason to combine the pair of sounds?

This should be a brainstorming session first. Then ask about sounds. Using two phones with the same tone app (there are several free ones available), discuss reasons for combining the sounds.

b) What would you need to do before adding two images together? List several things in the journal below.

Go to the two images you were looking at (either the galaxies or Jupiter). What would need to be done to combine them? (Align, size, orientation, etc.)

c) In what ways could the sonification setting in Afterglow Access be used in this task?

This should be a question that sparks their imagination. It does not work for this right now, but how could it be used?

3. QUORUM ACTIVITY

A very important part of this activity is to figure out what the matrices look like before outputting them to the console output window. Following the code will help them with their computational thinking skills!

Part Q - Two Asteroid Images

Let the students choose any other Kleopatra image. They will soon see two images taken further apart in time are the easiest. Actually, have them do two images that are consecutive to see how much harder it is - maybe do this first! There are several questions about the method they used and if the group can come up with some accessible methods.

Encourage discussion!

They also have the opportunity to use 3 other tools here. This is mostly for exploration, with the possibility of the asteroid showing up (stacker tool).

Again, a group discussion is helpful.

Part R - Plotter Tool

1. Before going to Afterglow Access, what do you think the Plotter tool is used for? Record one or two thoughts in the JOURNAL BOX.

Encourage them to make some kind of prediction!

b) What do you think the graph shows? Record what is on the x and y axis.

b) y is pixel value, x is the pixel distance along the line which has been drawn. The minimum x value will always be 0, the maximum x will be the length of the line drawn.

c) Make a new measurement on the same image.

c) It replaces the previous cross -section

d) The first drop-down menu under the graph is the mode. Try plotting in the two different modes. Type something in the JOURNAL BOX about each.

d) This shows 3-D etc - fun!

e) The bottom table shows "Measurement" and "Value". If you have an image that is not from our Solar system, there are more than one set of values for the measurements "Start" and "End". Can you figure out what they represent?

e) The top measurement for "Start" and "End", are the positions on the image in x and y coordinates. The bottom number for "Start" and "End" are the RA and Dec (position on the celestial sphere).

f) The Length measurement gives three different units. List those in your JOURNAL. Do you know what they mean? Now look at the "Orientation" measurement. Compare that to the orientation of your cross section line. Record what the unit is.

Pixels, arcsecs, arcmins. Refer back to the sky angle measurements. Orientation is simply how many degrees counterclockwise with respect to the positive y axis.

5. Open two asteroid images again. Could the Plotting tool help you find the asteroid in the two images? How? Try the slider button that says "Sync Plot Across Files". Record your thoughts in the JOURNAL BOX.

The "Sync Plot Across Files" slider button will mark the measurement on all the asteroid images you have. It would be possible to measure how far it moved in each image. From there, there are several other graphs that could be made.

****NOTE: Centroid clicks: The click will then start at the center of the bright object. The two buttons, Planet Centroiding, Interpolate pixels really do not show anything. Tyler said it is probably for a more advanced look - but he was not sure what they were supposed to do:**

Planet Centroiding:

Interpolate pixels:

Credits: **Innovators Developing Accessible Tools for Astronomy (IDATA)**, officially known as *Research Supporting Multisensory Engagement by Blind, Visually Impaired, and Sighted Students to Advance Integrated Learning of Astronomy and Computer Science*, and the resulting curricular resources, Afterglow Access software, and project research were made possible with support from the U.S. National Science Foundation's STEM+C program (Award 1640131). IDATA institutional collaborators include AUI, GLAS Education, Linder Research & Development Inc., Logos Consulting Group, TERC, University of Nevada – Las Vegas, University of North Carolina at Chapel Hill, and Universidad Diego Portales. Individual consultants on the project include Kathy Gustavson and Alexandra Dean Grossi. IDATA Teacher collaborators in the U.S. include Amanda Allen, Jacqueline Barge, Holly Bensel, Neal Boys, Tim Fahlberg, Kristin Grender, David Lockett, Matthew McCutcheon, Caroline Odden, Michael Prokosch, Kara Rowbotham, Rick Sanchez, and Barbara Stachelski. IDATA Student collaborators in the U.S. include Evan Blad, Naleah Boys, Ellen Butler, Jayden Dimas, Riley Kappell, Joseph Murphy, Logan Ruby, Alex Scerba, Charlize Sentosa, Meg Sorensen, Remy Streichenberger, Trevor Warren, and others. IDATA Undergraduate Mentors include Tia Bertz, Katya Gozman, Chris Mathews, Kendall Mehling, Andrea Salazar, Ben Shafer, Alex Traub, and Sophia Vlahakis. Special thanks to the IDATA external advisors including Nic Bonne, Al Harper, Sue Ann Heatherly, Russ Laher, Luisa Rebull, Ed Summers, and Kathryn Williamson.