

Seeing and Hearing the Invisible



Purpose: To explore how astronomers discover asteroids and determine their speed.

Instructions

1. Open the Afterglow Access (AgA) [Login \(skynetjuniorscholars.org\)](http://skynetjuniorscholars.org)
2. Log in with your Gmail or Skynet account. (If you are logging in for the first time, your email address will need to be verified by AgA.)
3. Open the AgA manual from <https://idataport.org/resources/> for reference if needed.

Part I: Align and Stack Images

1. Select the **Open Files** button.
2. Select the Sample folder.
3. Select the Solar System folder.
4. Select the Asteroid 216 Kleopatra folder. There should be 68 images in the folder.
5. Select the files Kleopatra_01.fits, Kleopatra_11.fits, Kleopatra_21.fits, Kleopatra_31.fits, Kleopatra_41.fits, Kleopatra_51.fits, and Kleopatra_61.fits.
6. Click on the **Open** button.
7. Click on the Kleopatra_01.fits file. Select the **Zoom to Fit** button.
8. Select the Show Aligner tab on the right. If the Kleopatra images are the only files in your file library list, click on the outlined box to the right of the **“Select Image(s) to Align”** drop-down menu. This button selects all of the images in the file library list.
9. Select Kleopatra_01.fits for the file in the **“Reference Image File”** drop-down menu. Finally, click on the **Submit** button.

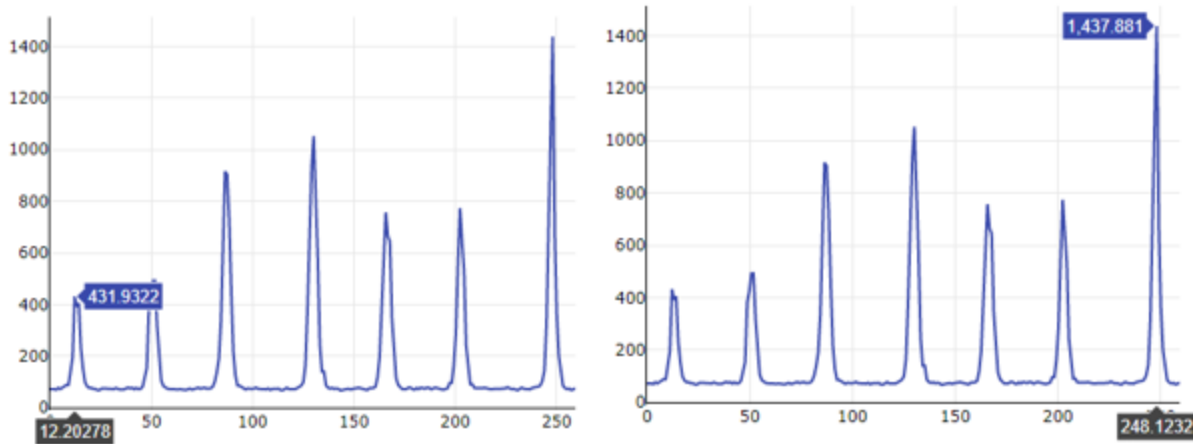
10. Select the Show Stacker tab on the AgA toolbar. Then, if there are only Kleopatra images in the file library list, click on the outlined box next to the **“Select Image(s) to Stack”** drop-down menu. This selects all of the images in the file library list. Then, click on the **Submit** button.
11. Select the **Zoom to Fit** button.
12. In the Display Settings tool, set the background level percentile to 89.2% and the saturation level percentile was set to 99.9%.
13. Download or take a screenshot of the image and save for your presentation!

Part II: Find the Asteroid and determine its speed

1. Find the Kleopatra asteroid on the aligned and stacked image. It looks like a series of bright dots on a diagonal line. Can you figure out which way it is moving?
2. Open the Plotter tool. The Plotter tool can be used to measure how far an asteroid has moved from one image to another image.
3. Select a point that is in line with the diagonal line of the Kleopatra images. Then select a second point such that the line passes through all the points where Kleopatra is.
4. The x-y plot in the Plotter tool has seven peaks. The x-axis location of each peak represents the pixel location of Kleopatra along the selected line.
5. Hover your mouse over two peaks in the graph to find the pixel position of two of the Kleopatra images.
6. To determine the distance traveled (in pixels), subtract the x-values for the two positions you chose. Below is an example using the first and the last peaks. Choose different peaks!

Name _____

Date _____



1. Open the File information tool for each of the images you selected and find the Center Time (when the image is taken). Example for the first and last peak is shown below. Get the data for your own peaks.

Center Time	2008-11-11 23:56:12 GMT+0
Center Time	2008-11-12 04:35:01 GMT+0

2. Determine the time elapsed between the two positions.
 3. Determine the speed of Kleopatra in pixel/second.
- *Note: We will learn how to convert pixel/second to m/s in another lesson. For this, we need to gather additional information about the position of the asteroid when the image was taken.*

Work space for part II: Insert a picture showing the peaks you selected, the data, and the calculations.

Part III: Add the Music

In this part of the activity, you will explore the Sonification tool and add sound to your aligned and stacked image. Open the Sonification tool (music note in the right panel). The default settings are shown in the picture below. Try different settings by changing them one at a time. Record your best song and save it for your presentation.

The screenshot displays the Sonifier application interface. On the left, a star field image is shown with a red selection box. The right panel, titled 'Sonifier', contains the following settings:

- Region Mode: Custom Viewport
- Time Navigation:
- Tone Navigation:
- Selection Options:
- Region Size: 932 x 955 pixels
- Start Pixel: (0, 0)
- End Pixel: (955, 932)
- Duration: 10
- Tones: 22
- Keep selected region in viewer
-

Part IV: Make a model of Kleopatra

1. Use radar images of 216 Kleopatra to create a clay model of the “dog bone” asteroid
2. Create a plaque that explains how a radar was used to collect the data and create the images of Kleopatra.
3. Include some facts about Kleopatra.
4. The linked articles below are a good source of information but you can also find and use other sources.

Radar images of Kleopatra (article)

<https://news.cornell.edu/stories/2000/05/radar-shows-giant-bone-shaped-asteroid>

Name _____

Date _____

Astronomers Catch Images of Giant Metal Dog Bone Asteroid

https://nssdc.gsfc.nasa.gov/planetary/news/kleopatra_pr_20000504.html