

## 3. Asteroid Basics

Asteroids do not give off their own light, but reflect sunlight as they orbit the Sun, like planets and moons. They change position in our starry sky as they orbit the Sun. Since they are part of our own Solar System, they are closer to us than the background stars. Most asteroids are found in the inner Solar System, inside the orbit of Jupiter. Even though they are moving very fast in their orbits, thousands of kilometers per hour, they appear to move slowly through the sky, since they are many millions of kilometers away from us. The asteroids that are closer to the Sun move faster than those that are farther out near the orbit of Jupiter. Our

Earth also orbits the Sun and rotates on its axis, so it is the combined motions of the asteroids and Earth that cause the shift in positions of the asteroids in our images. The speed of an asteroid in its orbit does not vary as much as speed of a comet, since asteroid orbits are usually not as elongated as comet orbits.

Asteroids are much smaller than most moons and planets. They range in size from a few hundred meters to a few hundred kilometers. Bodies that are a lot less than a hundred meters or so, would probably be categorized as meteoroids and not asteroids.

### Investigation

Developed by HOU Leader, Vivian Hoette

## How Do You Find An Asteroid?

In this investigation, we use four different methods of finding asteroids using Image Processing software tools.

- 1. Visual inspection.** Open the images `sappho_a508.fts` and `sappho_a533.fts` from the “asteroids” image folder. Click and drag the image windows to move them side by side. The image `sappho_a533.fts` might appear quite peculiar when first opened. Adjust the Min/Max settings as needed. These images are of the same region of the sky but were taken about 15 minutes apart. One of the objects in the image is an asteroid named Sappho. It appears to be moving relative to the background stars because it is closer to Earth. Select a color palette and adjust min/max until you see enough objects in the image to compare and match patterns. Can you tell which object is Sappho? Prepare a separate paper worksheet and write down the (x,y) coordinates of Sappho in each image:

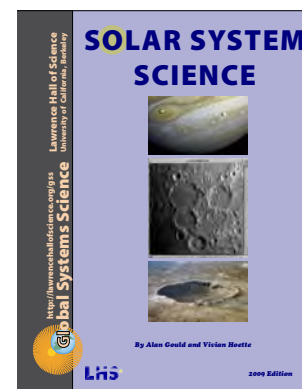
In `sappho_a508`: X= \_\_\_\_\_ Y= \_\_\_\_\_

In `sappho_a533`: X= \_\_\_\_\_ Y= \_\_\_\_\_

- 2. Slice tool.** Open the files `Hildrun1.fts` and `Hildrun2.fts`. These images were taken 15 minutes apart. Of the three bright objects, two are stars and one is an asteroid. How can we find the asteroid? Decide which one you think is asteroid Hildrun.

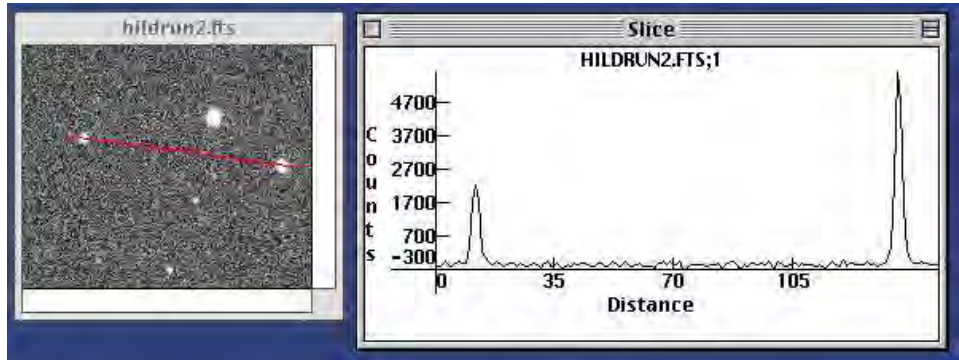
It might help if you could compare some distances between the three bright objects, since the distance between the two that are stars would not change. The distances between a star and an asteroid will change.

Use the Slice tool in the Data Tools menu to measure the distances between the three bright objects. Compare measurements in `Hildrun1.fts` to measurements in `Hildrun2.fts` to determine which object is the asteroid.



This investigation is adapted from Solar System Science, from the *Global Systems Science* series

Using the slice tool (or “Plot Profile”) to measure the separation of two stars (or star and asteroid)



Write down the coordinates of asteroid Hildrun in the images Hildrun1.fts and Hildrun2.fts?

Hildrun1: X= \_\_\_\_\_ Y= \_\_\_\_\_  
 Hildrun2: X= \_\_\_\_\_ Y= \_\_\_\_\_

**3.Subtracting Images.** Another nifty tool to use in finding things that have moved in two images (such as asteroids) is the **Subtract** tool in the **Transform** menu (HOUIP 2.0).

- Open Hildrun1.fts and Hildrun2.fts.
- Click on Hildrun1.fts. In the **Transform** menu, select **Subtract** (or click on Subtract icon in the Tools Palette).
- You can choose either, “File from disk” or “Displayed Image,” then choose Hildrun2.fts as the file to subtract from Hildrun 1.
- Click on **Display in new window**. Click OK.
- View your results. The image processor has subtracted the brightness Counts of every pixel in the first image from each corresponding pixel in the second image. Do you see an object with a double position? It will be a black object at its initial position in Hildrun1.fts and a white object at its position in Hildrun2.fts. Is this the object you thought was the asteroid?



**4. Compare Images (Blink Comparator)**

Open Ryokan1.fts and Ryokan2.fts. These images were also taken 15 minutes apart. Most of the bright objects are stars. One is asteroid Ryokan! Try using the “Compare Images” function in the Analyze Menu to identify which dot is asteroid Ryokan.

Write down the coordinates of asteroid Ryokan in the images Ryokan1.fts and Ryokan2.fts:

Ryokan1: X= \_\_\_\_\_ Y= \_\_\_\_\_  
 Ryokan2: X= \_\_\_\_\_ Y= \_\_\_\_\_

The images of Hildrun and Ryokan were taken for HOU with the 3.5 meter telescope at Apache Point Observatory in New Mexico from the Adler Planetarium & Astronomy Museum by University of Chicago Astronomer, Dave Cole.

**5. Which one is Iris?**

Write down the coordinates of asteroid Iris in the images Iris1.fts and Iris2.fts?

Iris1: X= \_\_\_\_\_ Y= \_\_\_\_\_  
 Iris2: X= \_\_\_\_\_ Y= \_\_\_\_\_

Which method did you use to find Iris?

# Make an Asteroid Movie

The image to the right was taken from Earth by astronomers using a telescope and CCD camera. There's an asteroid in this image. Can you tell which object is the asteroid? Go ahead and circle it, before proceeding with this investigation. We'll see if you're right later on.

Astronomers use various exposure times for astronomical images. With shorter exposures it can sometimes be difficult to recognize the asteroid. But what if we had whole bunch of short exposures of the same part of the sky taken at different times? We could use movie-making software like Windows MovieMaker or the Mac iMovie to create a time series video. The distant background stars and galaxies should remain stationary and the asteroid should appear to move.

Find the folder labeled A771A\_Asteroid\_jpg which has a series of 66 images of asteroid A771A that were taken about six minutes apart (starting with A771A001c.jpg). Each image was taken using a two-minute exposure so you don't see the asteroid as a streak, however the asteroid moves slightly from one image to the next.

Using either Windows MovieMaker or Mac iMovie to create an asteroid video.

*If you've never used MovieMaker or iMovie then there are a number of quick tutorials out there for you to use. In the folder along with the rest of the images for this activity is a document named MakingMoviesHandout.pdf. Use this document to familiarize yourself with the software, or go online to YouTube.com and search on MovieMaker tutorial or iMovie tutorial and view one of the many useful online tutorials.*

To begin the process you will need to import a series of jpg images into either MovieMaker or iMovie. There are many ways to approach this so feel free to be creative. For example, you might only import the first 15 images, or you could import every 5th image (image 1, 5, 10, 15 ...).

Once you have all the images you want to use imported, drag the imported images into your movie in sequential order, and adjust the time for each image to 0.5 seconds.



Play your movie. Can you see the asteroid? Look at the image above again. Were you correct about where you thought the asteroid was located?

Go ahead and finish the movie making process by adding a title slide including your name, the name of the asteroid, school, and other information you teacher may ask for. Also add some audio. You can either import your personal voice comments or music, and add it to the movie.

**FINAL STEP:** The last step is to merge all the pieces together and create the movie as a single video file that you can share with others or post on YouTube. Refer to a YouTube tutorial or the MakingMoviesHandout.pdf document for instructions on how to do this.