

The National Schools' Observatory and Institute of Physics present: *Hunting for Asteroids*

Teacher Notes

Before starting the workshop, make sure all computers in the classroom have been directed to https://www.schoolsobservatory.org/discover/activities/hunting_for_asteroids and that all those attending have been given instruction sheets for the tasks you want them to perform. Also make sure they have your NSO student usernames and passwords to hand.

Introduction

Asteroids are dusty, rocky, metallic objects that orbit the Sun, but are too small to be considered as planets. They range in size from small pebbles up to the largest asteroid, Ceres, which is about 1000km in diameter.

Now that we have an idea what asteroids are, we can look at ways of finding them.

Whilst the positions of stars will remain fixed from night to night, the moon, planets and asteroids can be seen to wander slowly between them. Unlike most of the planets, asteroids are too dim to be seen with the naked eye. To observe them we need to use some binoculars or a telescope.



The path of Asteroid DA 2012 plotted on the night sky by the Stellarium software package, moving next to the relatively “static” stars in the background.

In this investigation you are going to hunt for asteroids using the ‘Liverpool Telescope’.

Getting the observations

Before starting this investigation, we need to get some pictures or images of the night sky. To see the movement of any asteroids, we need images that were taken some time apart, such that moving objects, which are much closer to us than the stars, will appear to have changed position between images. In fact, to make sure any motion we see is genuine, we are going to double-check by using three or four separate images, each taken about 30 minutes apart.

Obtaining the Image Sets

If you are registered, the image sets are available to download off the internet;

1) Downloading the observations

- Log on to www.schoolsobservatory.org/discover/activities/hunting_for_asteroids
- Head to the 'Data Files' section at the bottom of the page
- Click on the observations to download

Students will need to enter a suitable username and password before they can access any downloads. For your first attempt, use the demonstration image set (ah-demo-1.fits, ah-demo-2.fits etc.) as the images contain known asteroids for your students to spot.

Following this try a new set of asteroid observations; either the other images available on the above webpage, or try some new observations by heading to the *Asteroid Watch* webpages: https://www.schoolsobservatory.org/discover/projects/asteroidwatch/ast_download

For your chosen image set, **right**-click on each of the four images in turn. In each case, select 'Save Link As' from the available options and that will open a dialogue box asking where you want to save the image. Make sure you save all four images in the same location and more importantly, remember where you put them. Now that we have all our images, we can start our investigations.

Hunting for Asteroids

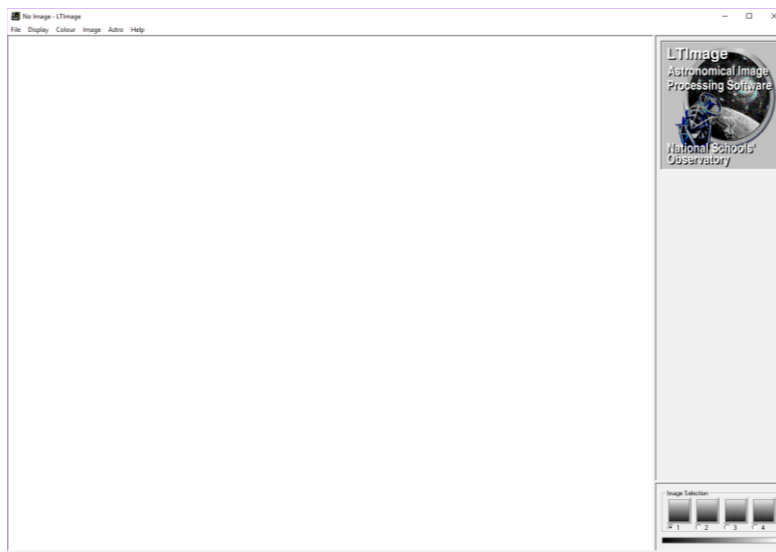
In order to look at the images, we need to open a special piece of software called *LTImage*.

Starting LTImage

If the NSO software has been installed onto your school network, you should be able to open *LTImage* via the Windows 'START' button (bottom left corner of the screen). After clicking on 'Start', move the mouse pointer over 'All Programs' >> 'Schools Observatory' >> 'LTImage' (the folder) and then click on the 'LTImage' icon. If you can't find this icon, check with your local IT manager beforehand to find out how to open *LTImage*.

Download LTImage for free from <https://www.schoolsobservatory.org/obs/software/ltimage> then Extract the files and double click on LTImage.exe to launch the software.

When you launch LTImage the following window should soon appear:



The main viewing screen of *LTImage* remains blank because there are no images currently loaded. The lower right portion of the *LTImage* window (see below) confirms that all four image stores are empty since no preview images are shown in the small boxes above the numbered image stores. Check that the first image store is selected, such that a dot appears in the little circle next to the number 1, as follows.



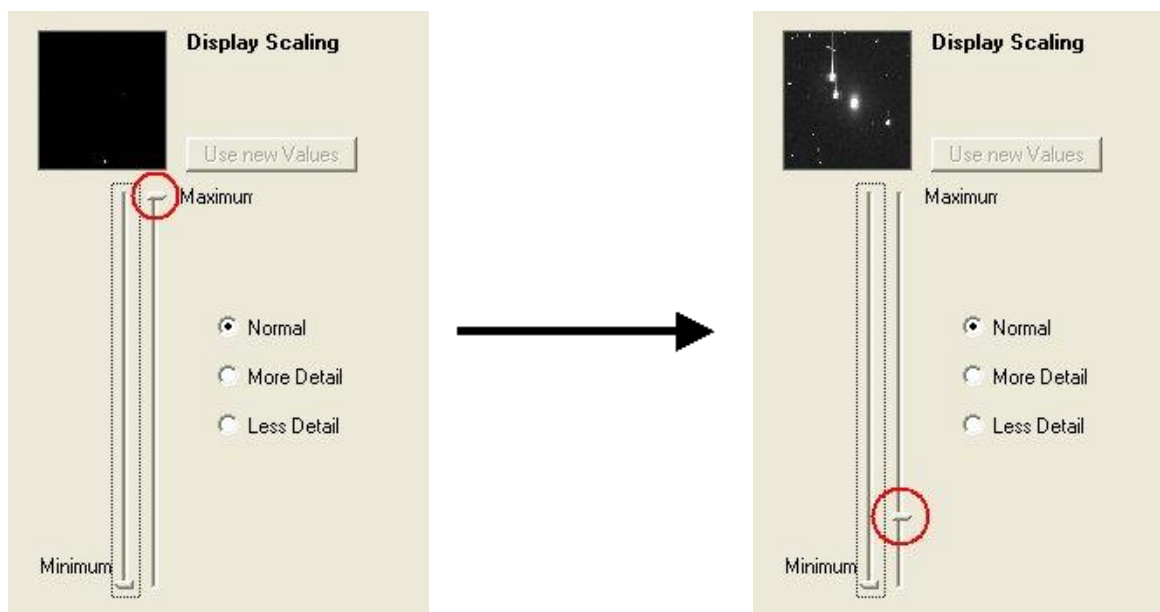
Load the Image Set

We can now load in the first image file. To do this, open the main '*File*' menu at the top left of the *LTImage* window and select '*Open Data Image*'. This opens a new dialogue box that allows you to navigate to the folder where you saved your chosen image set. When you have located your files, select the first image of the set, i.e. *ah-demo-1.fits*, then click on '*Open*' and it should soon appear in front of you on the main viewing screen.

Scaling the Image

At this point, you might be a little disappointed about the darkness of the image, but don't worry, this is normal and can be corrected for by *scaling* the image. It is worth mentioning that the camera on the Liverpool Telescope (also known as the detector) was designed to count the number of photons (packets of light) it receives, rather than to take pretty pictures. When an image appears dark like this, it just means that some of the detail in the image is so dark, compared to the surrounding bright stars, that we can't initially see it. To reveal more detail from dimmer objects in the frame, we need to adjust the *scaling*.

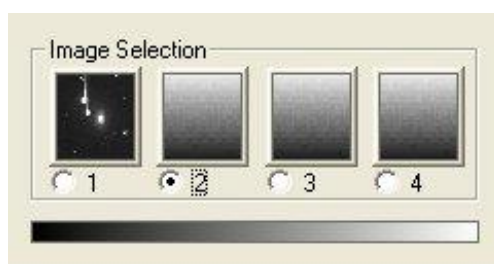
This can be done by opening the main 'Display' menu of *LTImage* and selecting 'Scaling'. You will then notice that two sliders have appeared on the rightmost panel of the window, as shown below left and right.



To adjust scaling, move your mouse pointer over the bar at the top of the right-hand slider of *LTImage* (circled). Now press and hold down the left mouse button, whilst slowly dragging the mouse down. Notice that the slider bar will follow. Keep an eye on the preview window above the sliders and you will see more detail start to appear. When you think you can see all the detail, and it's still not too bright, release the left mouse button and then click on the 'Use new Values' button above the sliders. This should apply the scaling corrections you just set to the main image and you should see far more detail. You may need to do this a couple of times before you get the right settings. You could also experiment with the left slider and 'More/Less Detail' buttons to see if they improve matters.

One down... three more to go

We now need to select the second image store, which should still be empty at this stage. Once again, you can do this by moving the mouse pointer to the circle next to the number 2 and left clicking. Alternatively, if your image selection box is highlighted (by a dotted box around the numbers) you can use the arrow keys on your keyboard to move between them. Now select 'Open Data File' from the 'File' menu and load in the second image file, i.e. ah-demo-2.fits. Now adjust the scaling using the same settings you used for the first image.



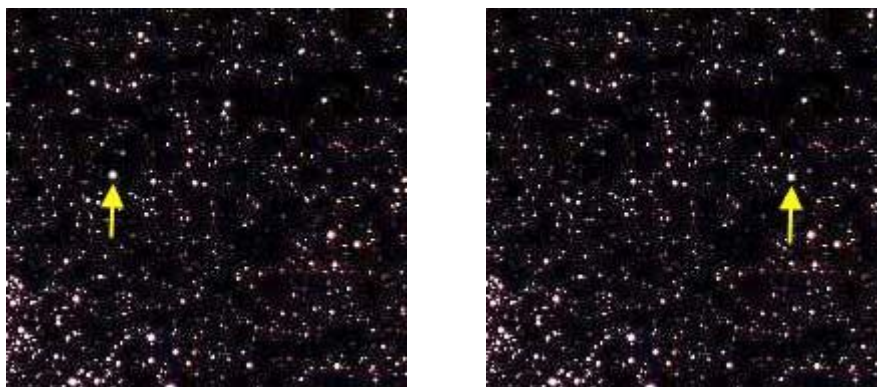
Repeat the process for the third and fourth (if available) images in the set, which should be loaded into image stores 3 and 4 respectively. You should now have the full set of image files loaded into each of the image stores of *LTImage*.

Comparing the Images

We are finally at a point where we can look for asteroids, and will do so using a technique known as *blinking*. To blink the images we simply look at the main viewing screen in *LTImage* and switch between each of the four images in quick succession. So for example, we would look at image 1 for about half a second, then at image 2, 3 and finally 4, before returning to image 1 and repeating the process. Don't forget that you can do this by highlighting the image selection pane and then using the arrow keys to move between images.

By switching in this way, your eyes should be able to detect any movement amongst the stars. Remember, all the stars will remain in exactly the same place, but closer objects such as planets, asteroids or even satellites will appear to move at a constant rate from image to image.

You may notice a slight shifting (or jitter) of all the stars in the image. This is due to very slight inaccuracies in the pointing of the telescope between images; however, it won't prevent you from seeing an asteroid. The following two images show an example of a moving object, but because there are so many stars in the picture, it's quite hard to see the object without blinking the images. In the example below, the images were taken 8 days apart and the moving object is actually the planet *Pluto*.



Images from April 2001 - left image taken 8 days before the right

If you loaded in the demonstration image set, you should be able to pick out the known asteroids within them (yes, there are two asteroids, although one is much harder to spot than the other). Keep blinking the images until you do. You may want to try varying the time you take before switching to the next image.

When you are happy that you can find at least one of the moving objects in the demonstration image set, try loading one of the real image sets to see if you can discover an asteroid. These images sets will be put onto the website as they are taken on the *Asteroid Watch* webpages:

https://www.schoolsobservatory.org/discover/projects/asteroidwatch/ast_download

Good Luck!

Advanced Task

Calculating the speed of an Asteroid

If you still have time and feel confident about using a little maths with the kids, there are some measurements we can make on the DEMO image set. By using some of the *LTImage* tools, we can work out how far the asteroid has travelled and indeed, how fast it's going. You can do this in ten basic steps by proceeding as follows –

1. Open the 'Astro' menu on the main tool bar of the *LTImage* window and select 'Size and Distance'.
2. Select the first image store by clicking on window one in the Image Selection pane.
3. Locate the brightest moving object and place the mouse pointer over it. Don't click the mouse button at this stage.
4. Leaving the mouse pointer where it is, use your arrow keys to move to the second image. The object will now have moved because we're now looking at the next image.
5. Now click and hold the left mouse button before moving it to the new location of the object. A yellow triangle will appear.
6. When the mouse pointer is over the new position, release the left mouse button and the triangle should turn blue. Try to point the mouse as accurately as you can.
7. On the right side of *LTImage* you can find the total number of pixels between the two positions. Write this value down on some paper.

Your images are made up of many thousands of pixels (image elements) or dots, but to calculate how far the asteroid has moved in units we can more easily understand, we need to find out the pixel scale, i.e. the real distance that one pixel represents. To do this –

8. Select 'Image Properties' from the main 'Astro' menu and select the 'Calibration' circle to the right of the screen.



9. Multiply the pixel scale value (km/pixel) by the number of pixels the object moved (the value you wrote down) to find the distance travelled.
10. Since speed = distance/time, divide the distance by 1800 seconds (time between images 1 and 2), to see how many km the asteroid moves per second.

For the DEMO image set, you should have got close to 6 km/s. For comparison, a passenger aeroplane would fly at about 0.2 km/s - about 30 times slower. Now that's a fast asteroid! If you're lucky enough to find an asteroid in any of the other image sets, try to calculate how far and fast that asteroid travels. Bear in mind however that any results you get from such measurements will be approximate, since we don't know exactly how far away each asteroid will be; and this uncertainty will reflect on the 'Pixel Scale' and hence the distance the asteroid appears to travel.

Good Luck!