In Focus

In the activity, F Box Explorations, you moved a paper screen toward and away from a lens until it was at the plane where the image came into focus. The images for this activity were taken using a 24-inch reflecting telescope. A reflecting telescope is one that uses mirrors to focus the light from a distant object. Instead of a paper screen, a CCD camera recorded these images. Just like your paper screen, the person taking these images had to make sure the CCD camera was at the focal plane. Instead of moving the CCD however, the secondary mirror of the telescope was moved with a small motor to bring the image into focus. The CCD is mounted at the end of the telescope. It can also be moved with a rack and pinion system, but astronomers find it preferable to mount equipment at a fixed position and move the secondary mirror of this telescope.

When you set up a telescope, point it at a distant object and record an image with your CCD, it is rarely in focus the first time. At the beginning of each observing session, a lot of focusing images are taken, but few are saved. Even though focusing is one of the most important steps in taking useful images, it isn't very often that beginners get a chance to really study the process. For this activity we have saved a bunch of out of focus images so you can learn what out of focus looks like. You will also learn to recognize when the image is getting closer to the focal plane and why precise focus is so important to astronomers.

Image sets needed for this activity are on the computers in 322 or you can download them from a link on the class web page.

Questions:

1. Think about or set up again the F Box experiment of Activity 4. Sketch your perceptions of the light path from the source, through the lens, and onto the imaging screen or detector at the focal plane. Label the object source, focal length, focal plane, the image and the detector.

2. Most of the images you will be using in this activity are out of focus. This means that the CCD camera is positioned someplace other than the focal plane. There are two possible areas the camera could be when you are looking at an out of focus image. Draw light converging onto a focal plane and shade in these areas where an image would be out of focus with a pencil.

3. Open your ImageJ or MicroObservatory software. Locate and open the images 5a-focus_star1.fts through 5a-focus_star5.fts.You are looking at a series of images taken as the telescope/CCD was brought into focus on a star. There is no way of telling which the focal plane was in front of or behind the CCD camera's detector. Sketch or describe with words the appearance of the star images.

4. Next, open image 5a-gam1andfocus2.fts. Make a prediction about what you think this image will be once it is brought into focus.

5. Open the remaining images for 5a-gam1andfocus.fts. Was your prediction correct? If you look carefully at the earlier images, could you have seen evidence of a hidden object? Explain or sketch the evidence.

6. Using what you observe in this set of images, describe what happens as you bring a telescope into focus.

7. Write a sentence that explains how focusing the telescope affects resolution, seeing detail in images.

Apply Your Knowledge:

8. Open the last two images.
9. Using what you have learned in this activity describe how you know that the first image is in focus. List the image processing tools that help you with this analysis. There is a nebula surrounding this bright star. Does improved focus help you discern this nebula better?

10. What do you know about the position of the CCD camera in the out-of-focus image?