Lab 4 - Part 1
Intro to Displaying Images with DS9

Please write your answers on a separate document, and include your group member names.

We'll use DS9 a lot this semester to display astronomical images. This brief intro will give you a bit of a flavor for the program, but we'll also learn lots of tricks as the semester goes on.

The directory you downloaded contains files ending in the suffix .fits. Double click on file "cluster_proc.fit". It will open in a program called "SAO Image DS9".

1. Once the file opens, mouse over the pixels in the image. What three numbers on the display are changing as you move the cursor from pixel to pixel, and what does each represent?

The first important thing to know about an astronomical image is what it is of, which may or may not be clear from the filename. One of the advantages of the .fits file format is that it stores not only a digital image, but a text file called a "header" that tells you about some relevant properties of the image. To see the header of a .fits file opened in DS9, click File → Display Header.

2. Display the header for the image you opened and find and record the following information:
    a. The target name
    b. The RA of the target
    c. The declination of the target
    d. The exposure time
    e. The filter used

Experiment with the options in the "zoom" and "color" menus until you're pretty sure you know what they do.

Open the image "M13-002_R.proc.fits". This is an image of the globular cluster M13 taken in the R band (which you could verify with the header if it weren't named so descriptively).

In the "edit" tab, select "region". Place your mouse at the center of the cluster, click and then drag outward. A green circle should appear. If you draw more than one circle, or want to start over and draw a new one, select the circle and hit the delete key on your keyboard.

3. Double click on the green circle and its properties will appear. Manipulate these to determine where you think the center of the cluster is, as well as its approximate radius in pixels. Record those numbers.

4. The size of a pixel on the Smith detector is 0.5” and the distance to M13 is 6.8kpc (kiloparsecs) from Earth. Translate your approximate radius of the cluster from pixels to light years.

Image Stretch: *One thing that you can and almost always should change in the image is the precise orientation of various colors within the colorbar (along the bottom of the image). To do this, you right click in the frame and drag the cursor:*

- *Drag the cursor **up and down** to change the absolute pixel value that corresponds to each color*
- *Drag the cursor **right and left** to change the contrast, which corresponds to the distances between colors.*

Do this with your image and note how different it looks when these values are changed. In particular, note how the colorbar at the bottom of the window changes! Often very different features within the image appear when you change this “image stretch”.

Changing the Scale: *Now click on the Scale menu at top, and select “Scale Parameters”. A histogram showing the number of pixels with various brightnesses will appear. The lower limit is the faintest pixel that will be given a certain color in the colorscale, and anything below this will be given that same color (represented by the red sliding line), and likewise for the upper limit (green sliding line).*

5. Describe in words what happens to the image if you do each of the following. It may help you to figure out what’s going on if you mouse over pixels where something interesting is happening so that you can read off their brightness values. It will also help to play with the color scale each time.
    a. Set the Low to 10000
    b. Set the Low to 0 and the High to 8000
    c. Set the Low to 1200 and the High to 1300

6. Based on your results, what do you think the Scale settings are useful for?

7. Try out a few of the different Scale options (“zscale”, “log”, “min max”, “linear”, “asinh”, etc). In your write-up, describe the effect of choosing different scales, noting how the colorbar scale limits change. You may also want to drag the cursor to modify the contrast/color orientation to bring out different features in the image. Be sure to quantify how the colorbar pixel values change with different scale settings.