Lab 1 - Calibration Frames, DS9

In Lab 1, we take the necessary calibration frames used during processing to remove various image artifacts. Calibration frames include dark frames, flat fields, and bias frames discussed in ASTR 203 p.9.

Dark Frames

Dark frames are simply images taken with the shutter closed, to record the inherent noise of a particular CCD, at the time of imaging. This noise can then be subtracted from your image files. http://en.wikipedia.org/wiki/Dark-frame_subtraction

To duplicate CCD background noise, dark frames are taken at the same duration, temperature, and binning as the light frames. A library of various darks is created and stored in desktop folders, for later use.

Procedure

To create and store dark frames, in CCD Soft Camera Control window, choose the **Autosave** tab. Select **Choose Folder** to create a desktop folder with an appropriate name: 5min1bindark 02-04-14 1min1bindark 02-04-14 1min2bindark 02-04-14

Camera temperature should be set to the observatory standard of -10.0.

In the **Take Image** tab, choose **Frame_Dark** and the **Imager** chip. Set the appropriate exposure time in minutes, and the correct binning. For **Series Of**, select 12. These will later be median combined to create a master dark for processing.

In the **AutoSave** tab, be sure **AutoSave On** is checked and type a prefix for your dark frames (i.e. 5min1bin). In the **Take Image** tab, click **Take Series** to take 12 dark frames and save them to the desktop folder. Repeat for other time and binning combinations as needed. Dark frames can be reused during semester.

Flat Fields

Flat fields are images taken of an evenly illuminated field to measure the response of the entire CCD chip, including issues such as pixel sensitivity variations, vignetting, and tiny dust particles. (dust donuts) This information is mathematically applied during processing, to flatten the images and make them uniform across the field.

Flat fields http://en.wikipedia.org/wiki/Flat-field_correction are taken for each imaging run, and not reused like dark frames. Focuser position changes and camera rotation, can result in shifts in the optical path, requiring nightly flats.

Procedure
We use 2 observatory methods for making flats: a white card / diffuser combination, and "sky" flats taken just after sunset. For making flats with the refractors (east wall) we locate 2 lamps by the telescope, equidistant from the telescope, aimed onto a white card located on the east wall. The telescope is also aimed directly at the white card. A diffuser is then placed over the front of the telescope to further soften the light, creating very flat fields.

For making flats with the 20" telescope we point the telescope at the sky, high in the east just after sunset. Tracking is turned off.

For both methods, use the **AutoSave** tab to create a desktop folder with the appropriate name (i.e. bin1flat 04-04-14). Do not choose **Auto Save On** yet, as we need to determine the exposure time.

In the Camera Control main window, under **Take Image** choose **Flat-Field**. In the **Take Image** tab take a 1 second test image at the appropriate binning, usually 1x1. For the 20" sky flats, a better starting point is .250 seconds.

Move the cursor around the image area and note the signal strength displayed lower left in CCDSoft main window. We are looking for a signal of ~35,000 for flats. This is about half the maximum signal of the CCD chip (65,535), and recommended by SBIG.

With the exposure time determined, select **AutoSave On** and in the **Take Image** tab, set **Series Of** to 12. These will later be combined into a master flat. With sky flats for the 20" telescope, exposure adjustments are made as needed during acquisition, to account for rapid brightness changes in the sky at dusk.

CCD camera flat field.

Bias Frames
Bias frames measure noise inherent in the CCD, not relative to exposure time. These are essentially zero exposure images, and numerous bias frames are combined to create a master bias. The master bias frame is then subtracted from individual flat frames, before creating the master flat. Bias Frames can be stored in desktop folders and reused.

Procedure
To take and store bias frames, create a desktop folder in the **AutoSave** tab with the appropriate name (i.e. bin1bias 02-04-14). Under **Take Image** choose **Bias** and set **Series Of** to 12. With **AutoSave** turned on, hit the **Take Series** button. These bias frames will be saved in the folder for later use in processing.

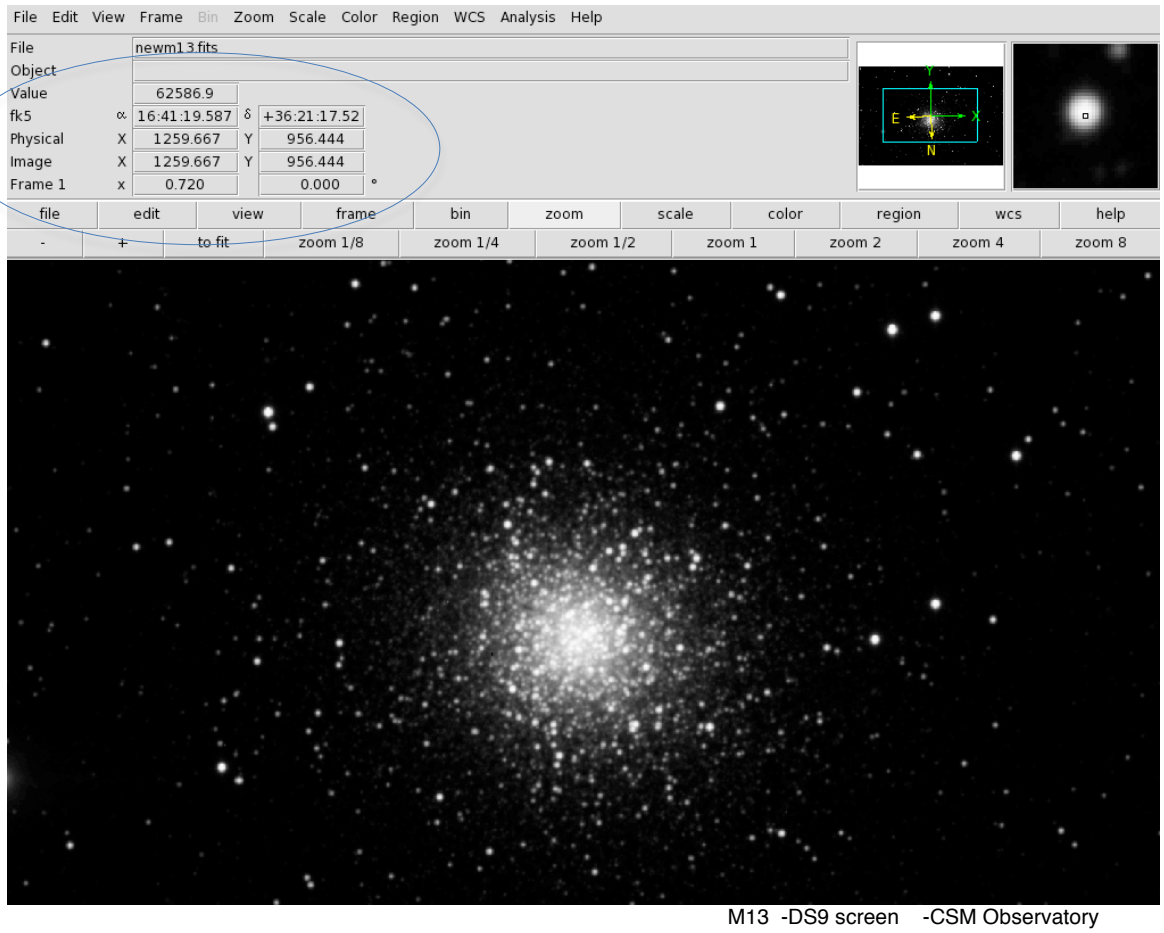
SAOImage DS9

DS9 http://ds9.si.edu/site/Home.html can be used to perform astrometry to identify coordinates of stars, objects, or individual pixels. http://en.wikipedia.org/wiki/Astrometry DS9 also performs image stretching and scaling, and other visualization functions, including display of the .fits header and false coloring for further image analysis. http://www.cyanogen.com/help/maximdl/FITS_File_Header_Definitions.htm

DS9 is used by many astronomers, and can be Downloaded from the address at top. Review NITARP tutorials 1-3. http://www.youtube.com/watch?v=C8QBwrKbEtc for a basic introduction to loading and manipulating image files with DS9.

Procedure

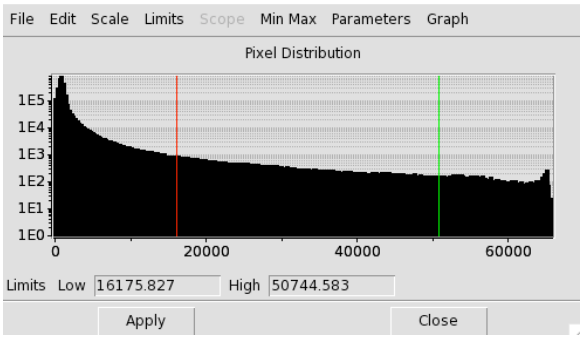
Load a processed galaxy, nebula, or other image in .fits format to DS9. Using the **zoom** tool, size the image to fit the window. While scrolling the mouse, notice the pixel by pixel values, plus RA and Dec (WCS http://fits.gsfc.nasa.gov/fits_wcs.html) of the currently displayed pixel. The CCD's x, y pixel position is also displayed.



M13 -DS9 screen -CSM Observatory

In the **scale** tab, investigate various options such as **linear, min max**, and **zscale** to reveal various highlight and shadow details.

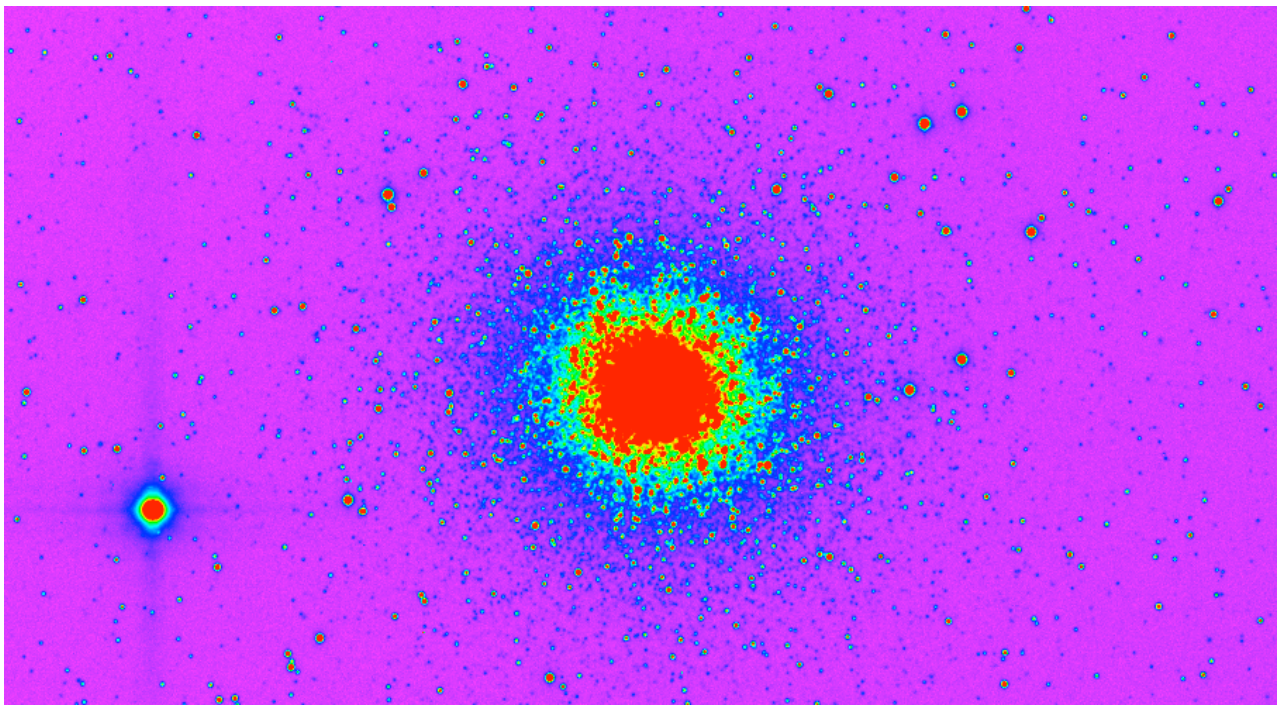
From the top menu, you can also go to **scale>scale parameters** to bring up a histogram window for image adjustment.



DS9 histogram

Also go to the **color** tab and experiment with DS9's false color options: (**a, b, heat**, etc.) While holding the right mouse button, drag the cursor left/right and up/down to explore and highlight various regions of clusters, nebulae, or galaxies.

The M13 image below is with the **rainbow** tab and shows variations between the middle and outer regions of the globular cluster. These variations are much less defined in a gray scale Image. Also, try imaging your target through different color filters (i.e. B and V) to observe variations in the image at different wavelengths.



M13 -DS9 false color -CSM Observatory