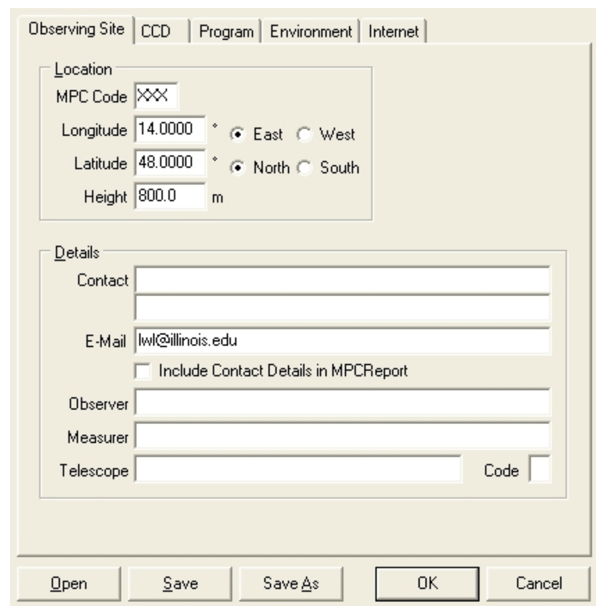
Astronomy 150
Asteroid Lab
Due in Class: Monday, Oct. 26

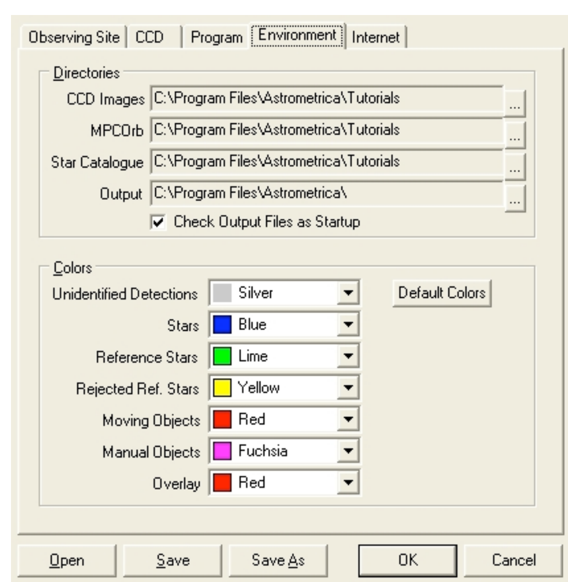
Section 1: First setup computer. (If this step is not correctly setup, nothing will work properly.)

1. Verify that lab computer is booted in windows (for Macs)
2. Create Folder on desktop, called Astro150
3. In start menu, under class programs, Astro 150, start Astrometrica
4. Click on the  for program settings (or click File, and Settings).

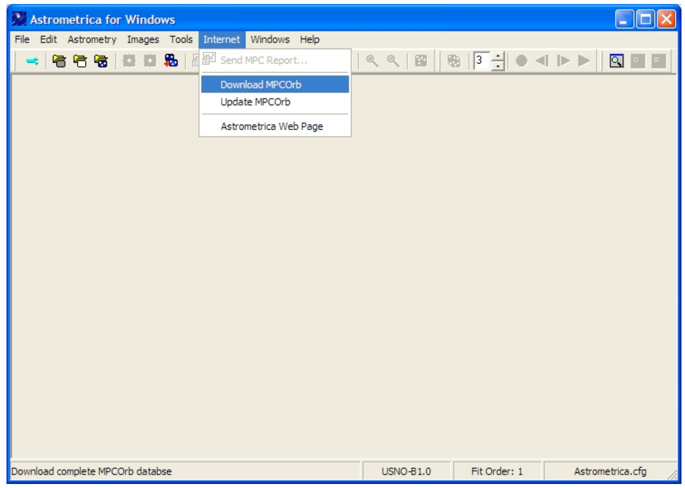
5. On the Observing Site tab of the Program settings, type in your email address, but nothing else at this time.



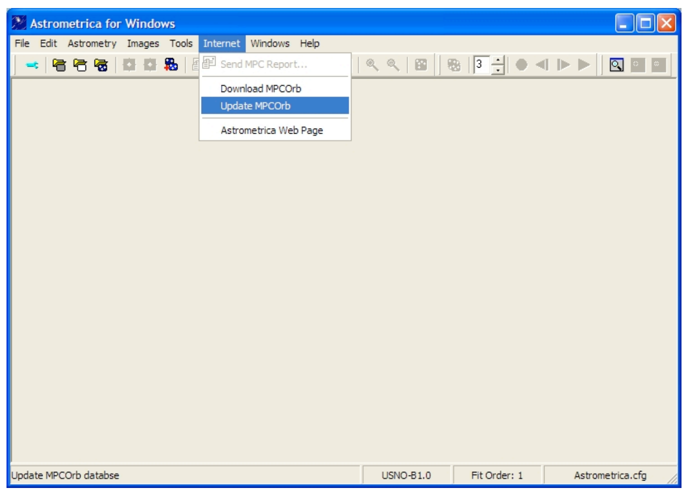
6. On the Environment tab of the Program settings, we need to change the Directories to:
   a. CCD images -> My Network Places, Entire Network, Network Services, Ics-midas, CLASS, ASTR 150
   b. MPCOrb -> your desktop Astro150
   c. Star Catalog -> your desktop Astro150
   d. Output -> your desktop Astro150



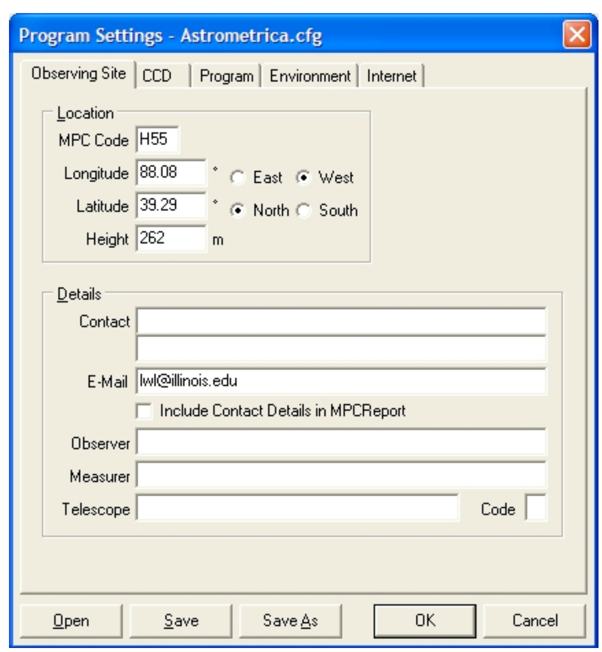
7. Click Okay and Save inputs
8. Click on Internet, Download MPCOrb. This will take a little bit of time.



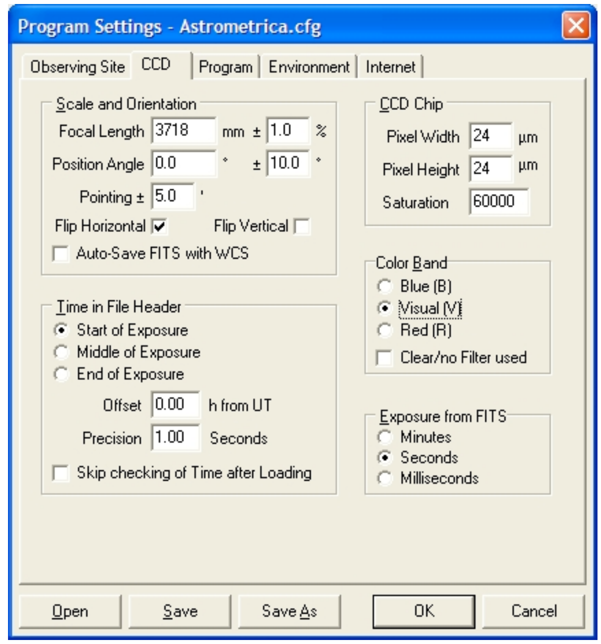
9. Click on Internet, Update MPCOrb, selecting all files. The updating database, after the download part, can take 5+ minutes. The program will look dead for a while. During this time, the instructor will discuss some background information, so heads up.



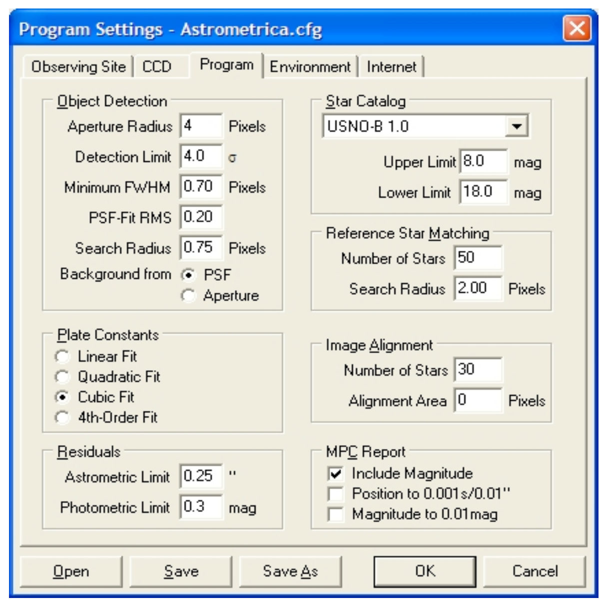
10. When the short discussion is over, and your Update MPCOrb is done, we need to go to the Program Settings again, start with Observing Site:
    a. Set the MPC Code to H55
    b. Set the Longitude to 88.08 <u>West</u>
    c. Set the Latitude to 39.29 <u>North</u>
    d. Set the Height to 262 meters



11. Then, go to the CCD tab in the Program Settings
    a. Set the focal length to 3718
    b. Set the pixel width and height to 24 microns
    c. Set the color band to Visual



12. Then, go to the Program Tab
    a. Set the Plate Constants to Cubic Fit
    b. Set the Residuals to
        i. Astrometric Limit to 0.25"
        ii. Photometric Limit to 0.30 mag

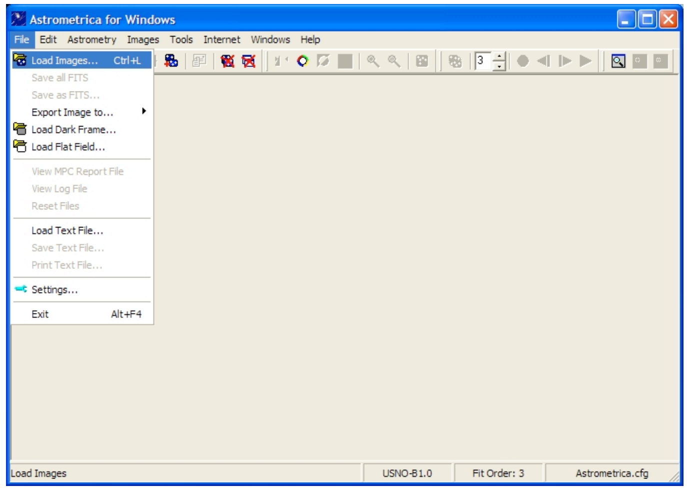


13. Click Okay, saving your changes

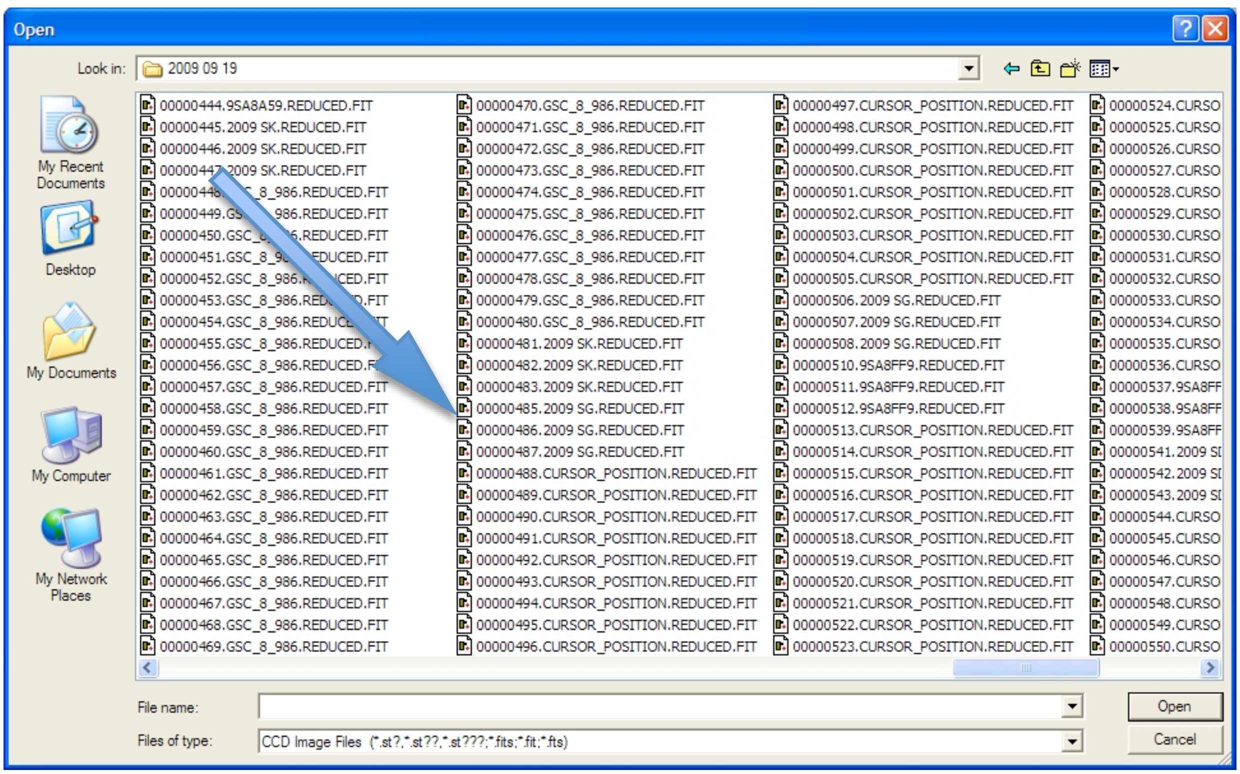
14. Now, we are ready to play with some data.

Section 2: Let’s Look at the NEA 2009 SG:
http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=2009+SG&orb=1

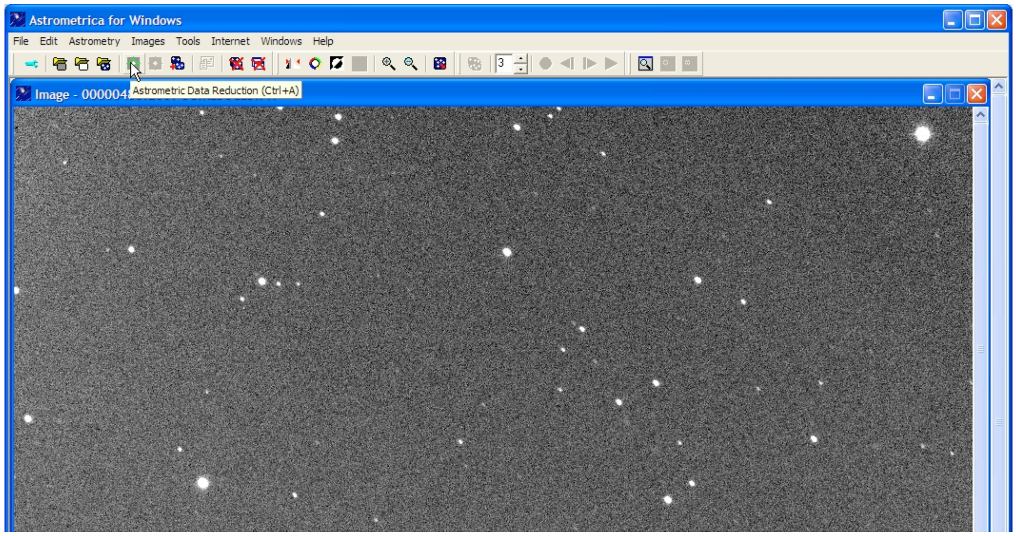
1. Go to File, Load Images, and open the directory 2009 09 19



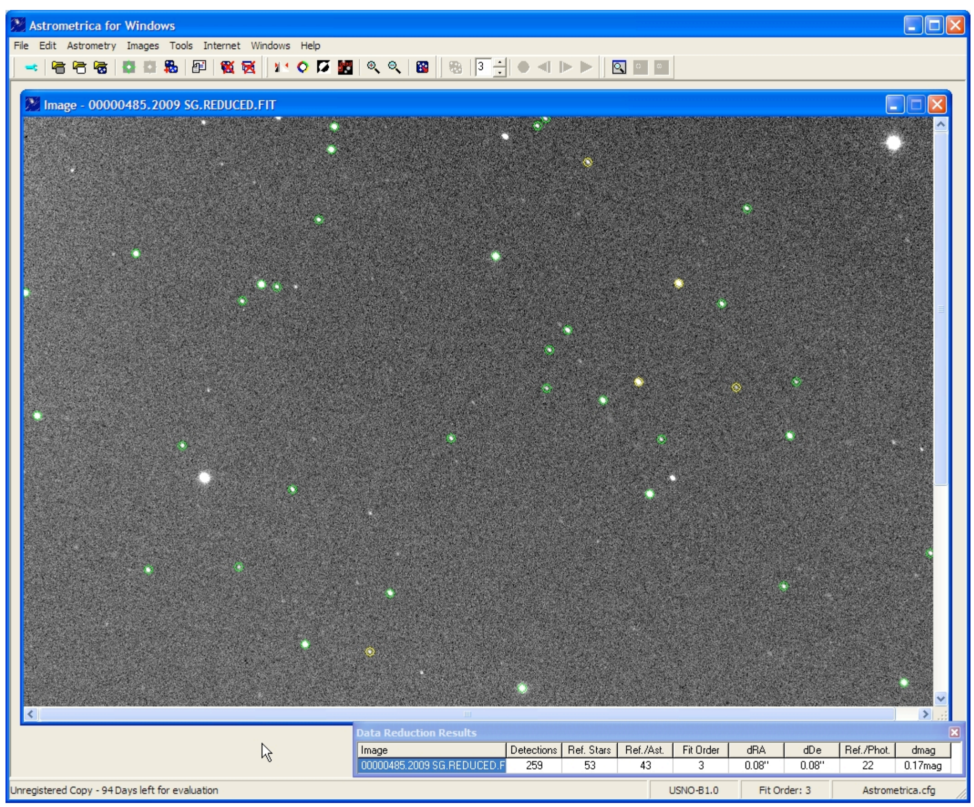
2. In the directory, scroll to find the File 00000485.2009 SG.REDUCED.FIT. This is where the dataset for the NEA 2009 SG begins. Open it.



3. If you did all the Settings right, you can now use the stars on the image to find the exact location of the telescope pointing. Press the data reduction button. 

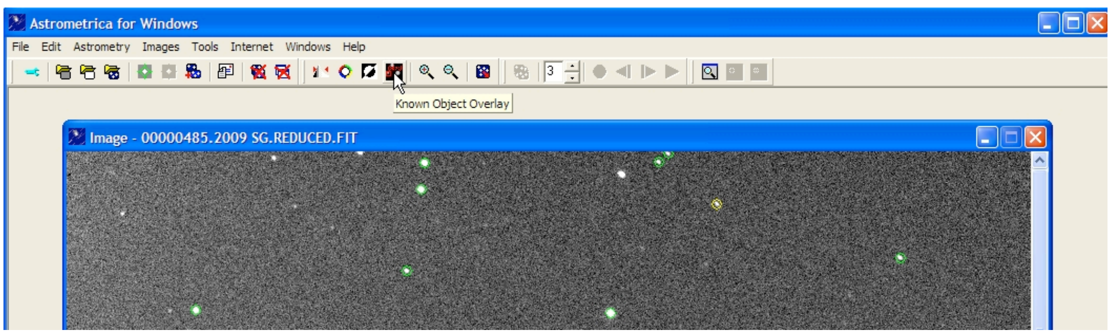


4. Click okay when the window pops up asking about the object name and coordinates.
5. If everything was setup properly, it should find the solution and show the following with circles around the standard stars.

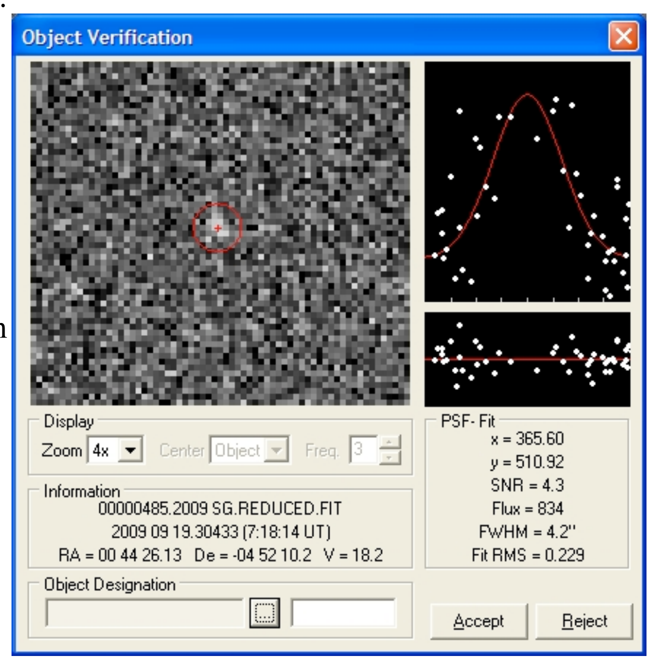


6. The colors used represent different objects. The default settings are:

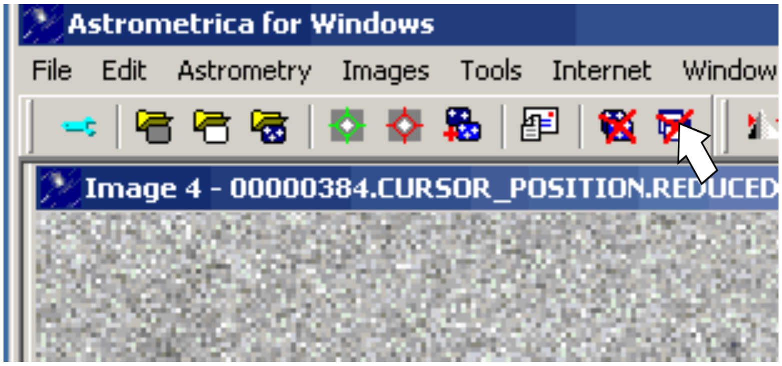
7. Now, since we know the true coordinates, we can check out where the known Solar System objects are in this image. Click on the Known Overlay Button.



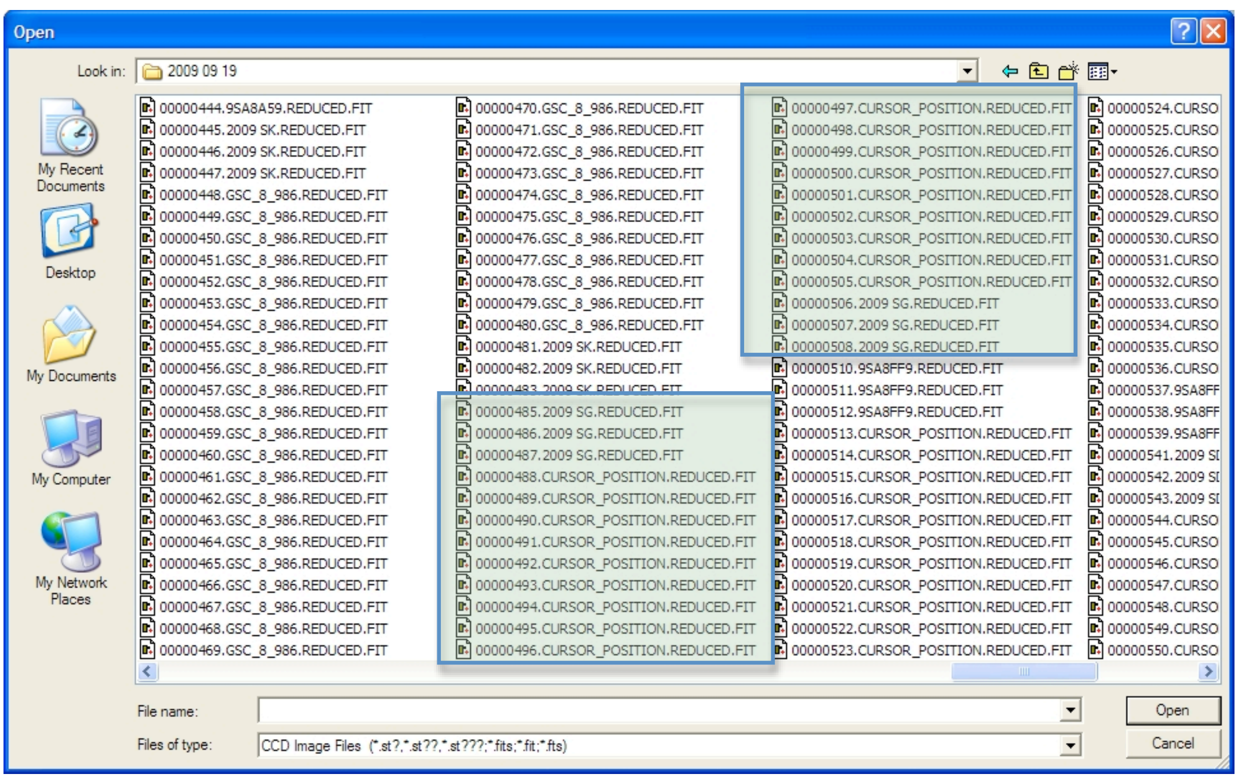
8. This will show two objects inside of squares. The one toward the North is labeled K09S00G, which is the NEA 2009 SG. Click the magnification button to see the small blob.
9. Put your cursor on the object and right click.
10. This brings up a window with the object and a fit. The data of this one observation is noisy (This is a dim object). If you click on the button next to the Object Designation section, the program looks for nearby objects (even though we know what it is). The object is 2009 SG, and the Program gives its brightness in magnitudes, how fast it moves, and in which direction. Go ahead and write down the speed and PA (direction of movement); we'll need these later. Then, click okay, and close the Object Verification window.



11. Finding asteroids in one image is very hard. So, we take many images over a few hours. Close all image windows, so we can look at more data. Click the close all windows button.



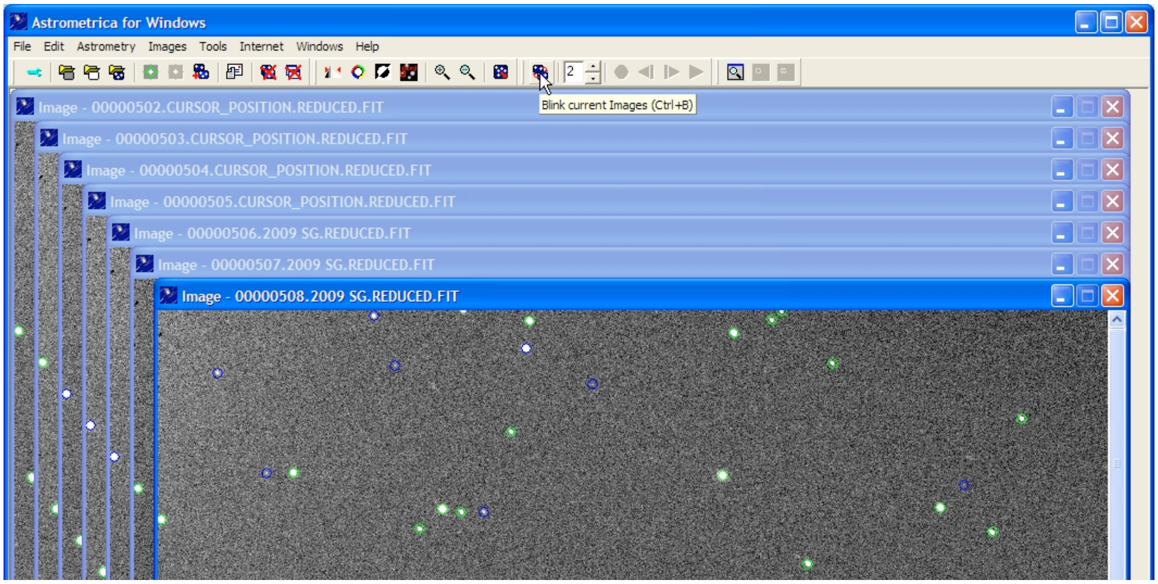
12. Go back to File, Load Images, and open the directory 2009 09 19. Find the same file as before, 00000485.2009 SG.REDUCED.FIT. This is the first data for this object and 00000508.2009 SG.REDUCED.FIT is the last file. The data have this format for all sources. The object name is in the filename for the first and last three files, with other names in between. Using the control button and right mouse clicks, choose five files over this night to view. The farther apart the more chance of seeing the asteroid move, so try to well sample the interval.



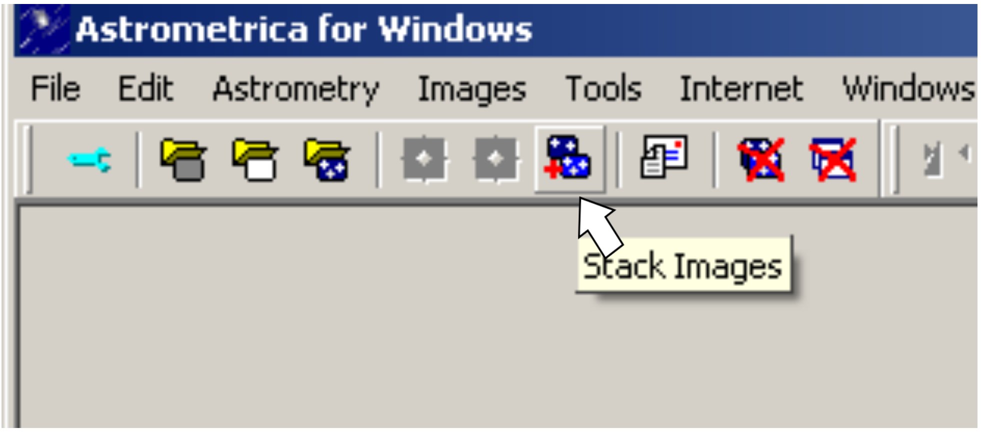
Note: Only the first and last few files in an image set will be labeled with the NEO's name.

13. After loading them, press the reduction button. (You will have to click Ok for each file). For this dataset, if the program is set up correctly, all frames should reduce without a problem.

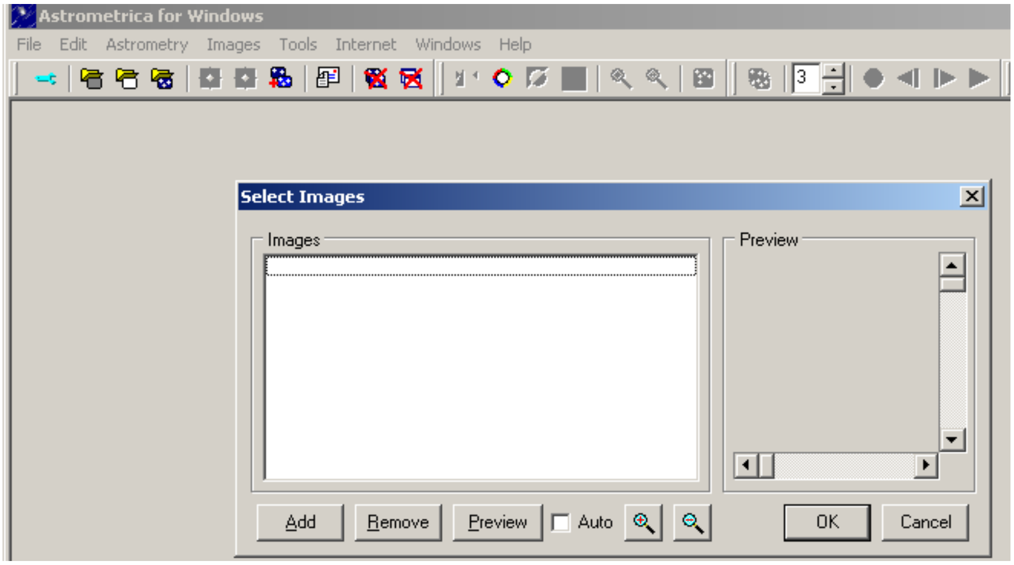
14. Now, click the blink button. This will make a movie of all the frames together.



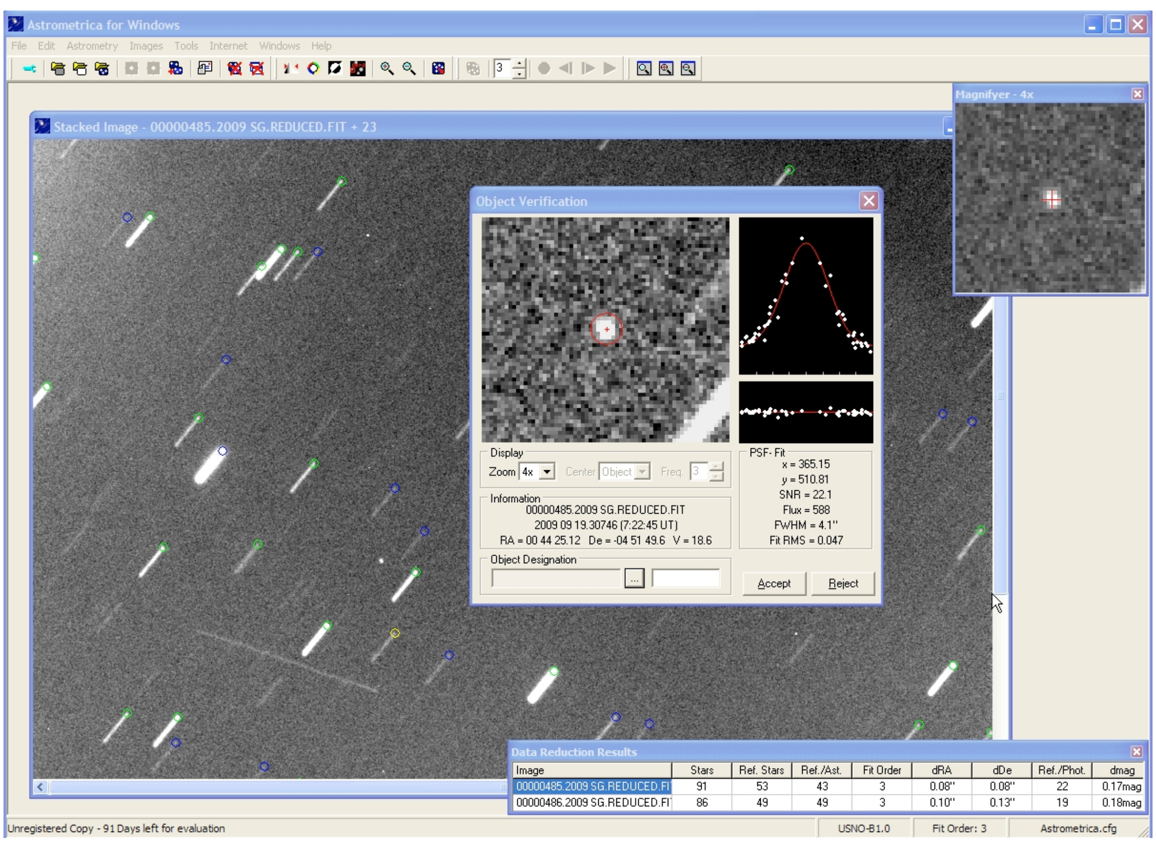
15. Now find 2009 SG. It moves, while the stars stay still.
16. Stop the blinking by pressing the stop sign button. Then, click on the Known Overlay Button, and see if you were right. Start the blinking again by pressing the Play button and watch it move. (This blinking method is probably the best way to find bright asteroids.)
17. Let's stack the windows around this source and see how much signal to noise we can get. So, close all images by pressing the Close All Windows Button again.
18. Click on the stack button.



19. We have ~24 datasets, so go ahead and add all of them, then click Ok.



20. You will have to hit Ok to verify positions for all datasets, so 24 times.
21. Then, the Coordinates, Tracking, and Stacking window, requires the operator to specify how the asteroid moves in Speed and PA. You can hit the … button next to the Speed, typing in the asteroid name should bring up the speed and PA, but VERIFY using your values from #10 above (5.74 "/min and 322.4 degrees), then click ok.
22. Note that the stars become streaks, but the asteroid is much brighter.
23. Measure the position and brightness using the same technique as in #10.



Section 3: Let's go do it!

The previous sections were for learning how to run the software; this section describes the assignment. Note that this can be done during lab session or you can do it at your leisure. If you do it later, you will have to redo the program settings and download the catalogs again.

The main point of this is to either find a new asteroid or measure properties of known ones. To get full credit for the lab, each student needs to examine three to five observing datasets (i.e. 3-5 different asteroid fields). We did 2009 SG in the computer lab, which is a single asteroid field. In some cases, you may not detect anything (just say so and skip the other parts), but in some cases there may be 4+ objects in one field. For each set of data, you **must** address the following issues. (Make sure the results are typed, i.e. no handwritten notes.)

1. What was the date of the observation? This is the folder's name.

2. What is the name of the source from the file name? For example, 2009 SG.

3. First, we want to look for an asteroid using the blink function. Load ~5 of the dataset files from that group, and do the data reduction. Any issues? If so, refer to the data reduction document on the class website for more info. (http://eeyore.astro.uiuc.edu/~lwl/classes/astro150/fall09/Docs/HardDataReduction.pdf) Describe how you fixed any data reduction issues.

4. Describe the images. Many stars or few? Anything interesting in the images?

5. Using the blinking option, find moving objects. Describe them. Describe their motion.

6. Using the Known Object Overlay, find all of the known asteroids in your field. Did you find all/any of them in the blink mode?

7. Did you find any yet unknown asteroids?

8. Pick one of the above asteroids to better measure its parameters. Write down the name.

9. To get the best signal to noise, we want to stack all the data for this source. As in Section 2 step 10, click near the asteroid and load the parameters of the nearest known asteroid. Write down the asteroid's speed and PA.

10. Using the procedure for 2009 SG (Section 2, steps 18-23), stack the data using the above speed and PA. Find your asteroid now (it should be a point source). Click on it to fit it with the best signal to noise. Write down its x and y position, FWHM, and V magnitude.