Measurement Tutorial

Now that you've mastered finding stars in the pattern matching game, here's a new challenge. How accurate are you at measuring the brightness of a star? Test your ability against members of the Center for Astrophysics. Good luck. Using the attached image of HATP-10, you'll measure the brightness of the target star, two comparison stars and two dark areas of the sky to get the most accurate reading.

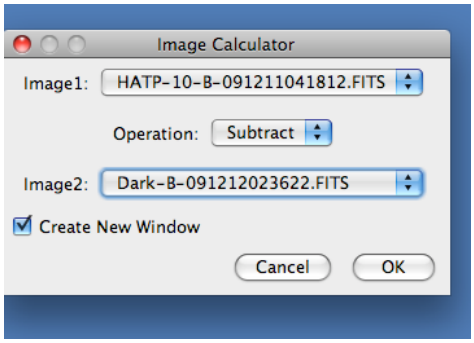
Step 1. – Subtracting out excess light

Open the opaque filter image – it's called (Dark-B-091212023622.FITS) in MicroObservatory Image.

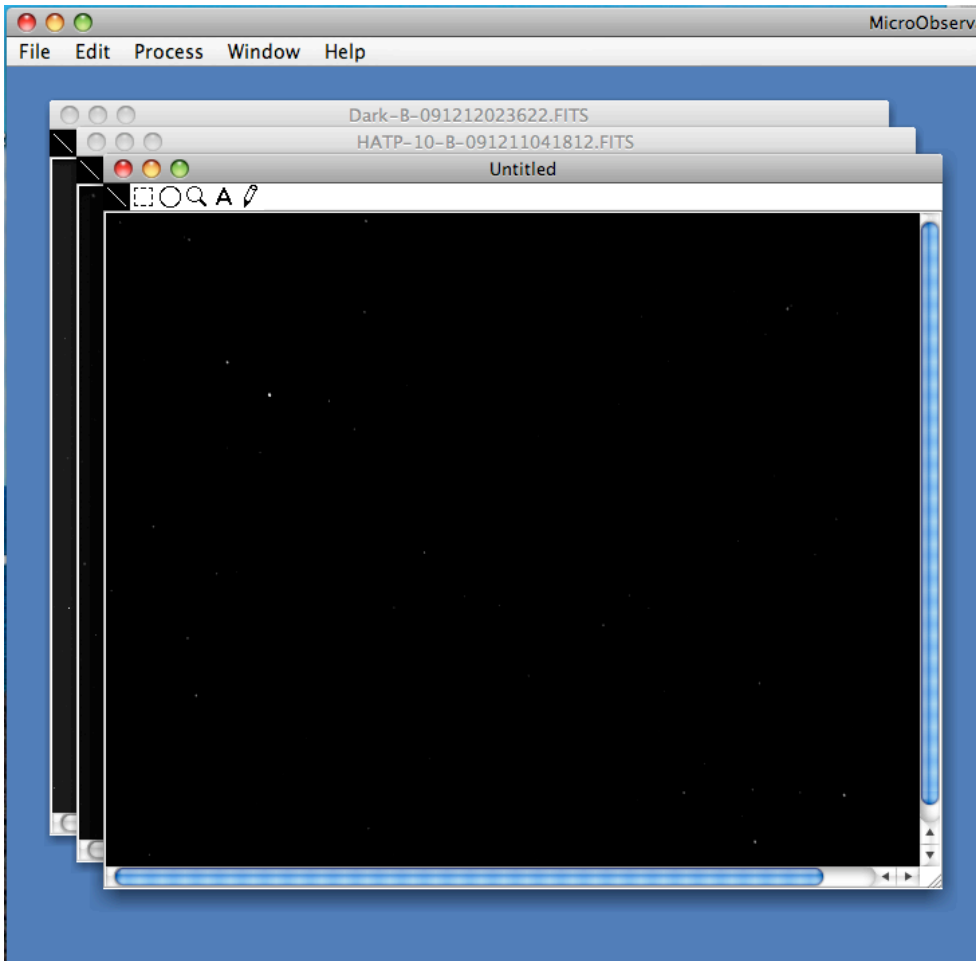
Open the FITS image of HATP-10 in MicroObservatory Image.

Under Process in the drop down menu select Image Calculator.

Subtract the opaque image from HATP-10 and hit ok.



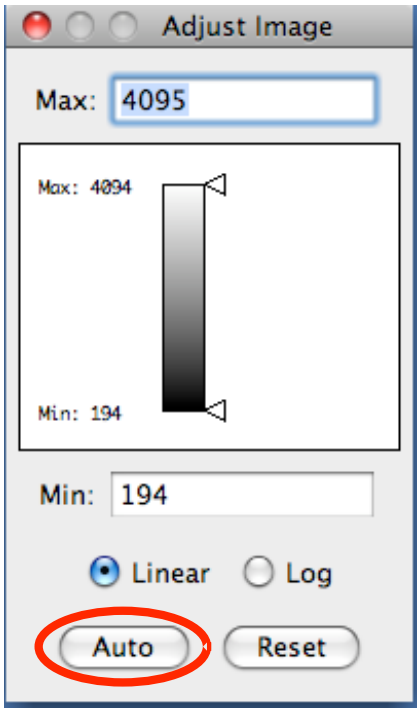
A third untitled image will be created. This is the image you will use for your measurements.



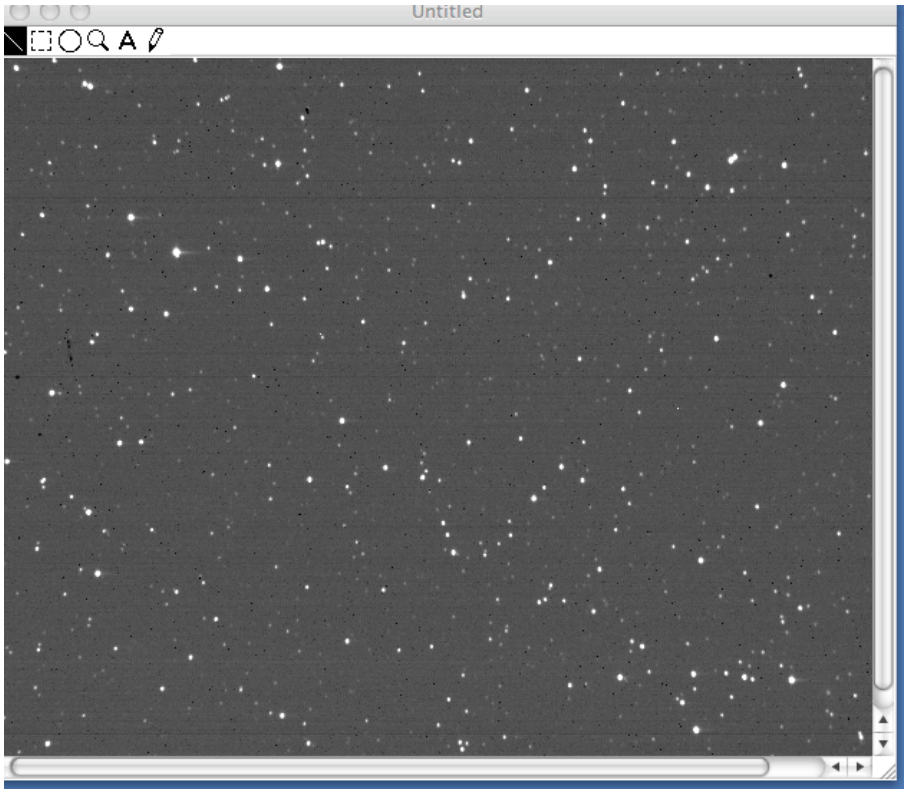
Why am I doing this? Light pixels that are simply noise associated with the telescope hardware have been subtracted from the image.

Step 2. – Adjust the image

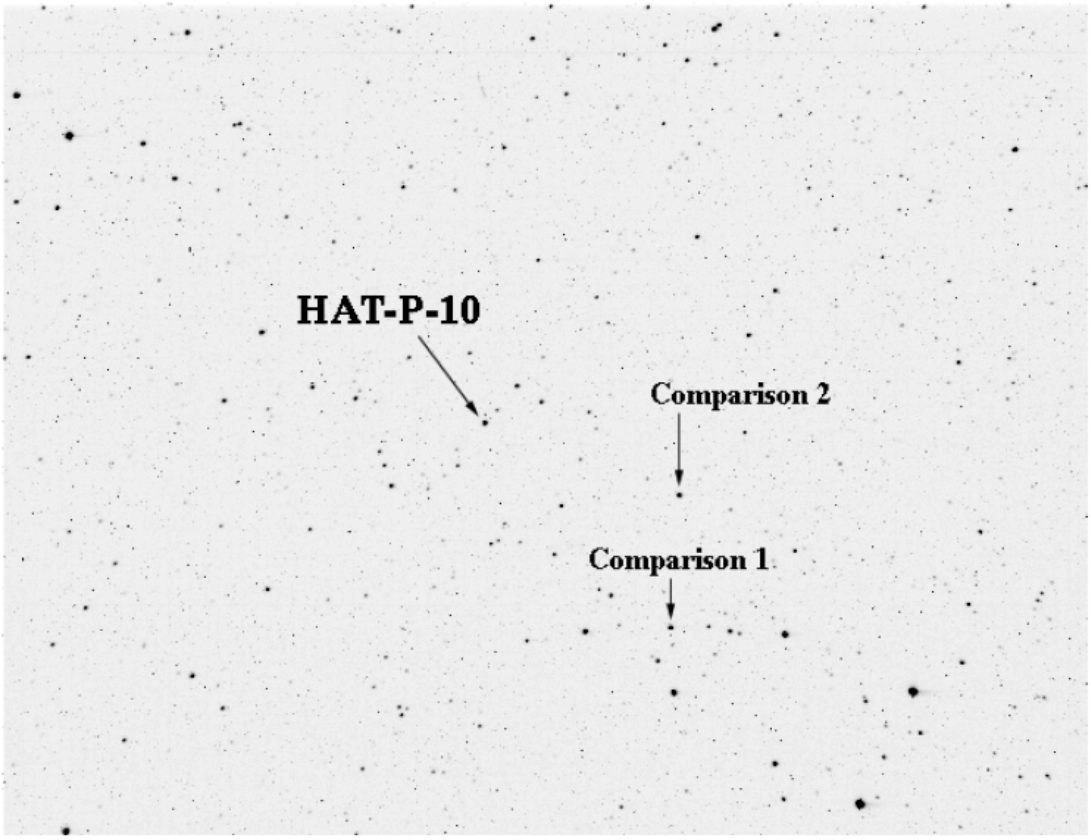
Under the Process menu, select Adjust Image. In the small window that opens, select Auto.



Why am I doing this? Adjusting the image will make the stars in your image easier to see.

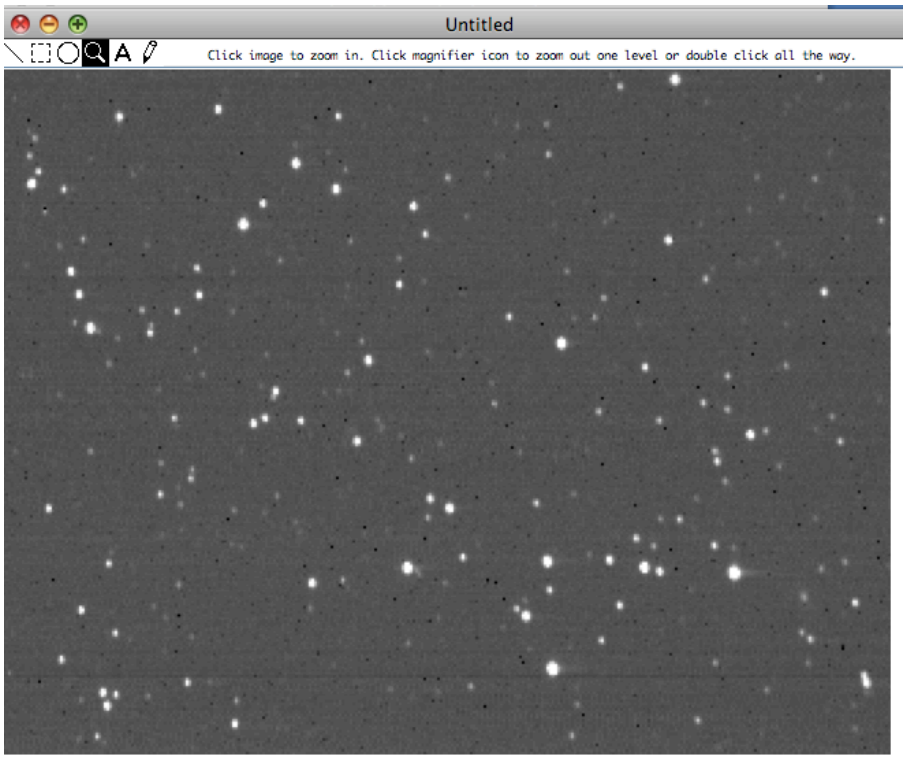


Step 3 – Locate HATP-10 and two comparison stars on this image using the star chart.



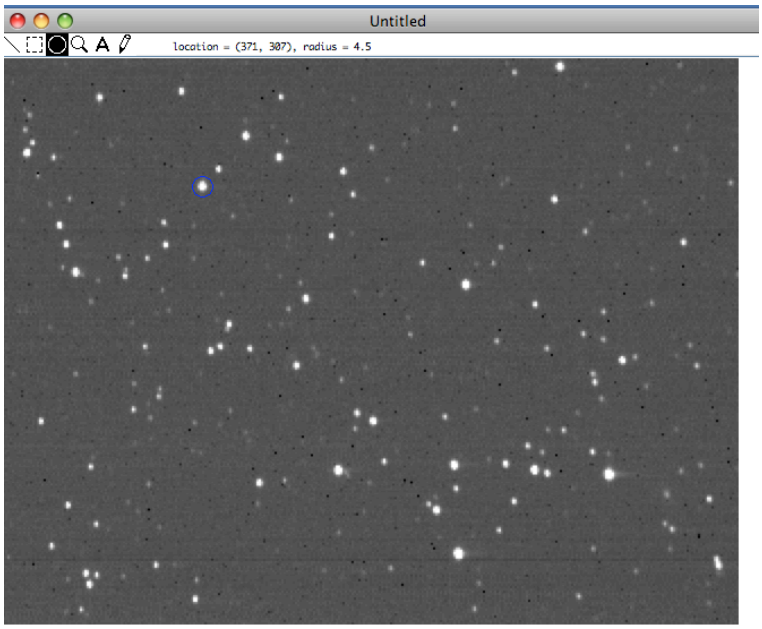
Step 3 – Measuring the brightness of a star

Click on the magnifying glass icon at the top left of the image. Move the cursor so it is centered between HATP-10 and the two reference stars noted on the star chart. Click several times to enlarge the image. HATP-10 and its two reference stars should remain in the field of view.

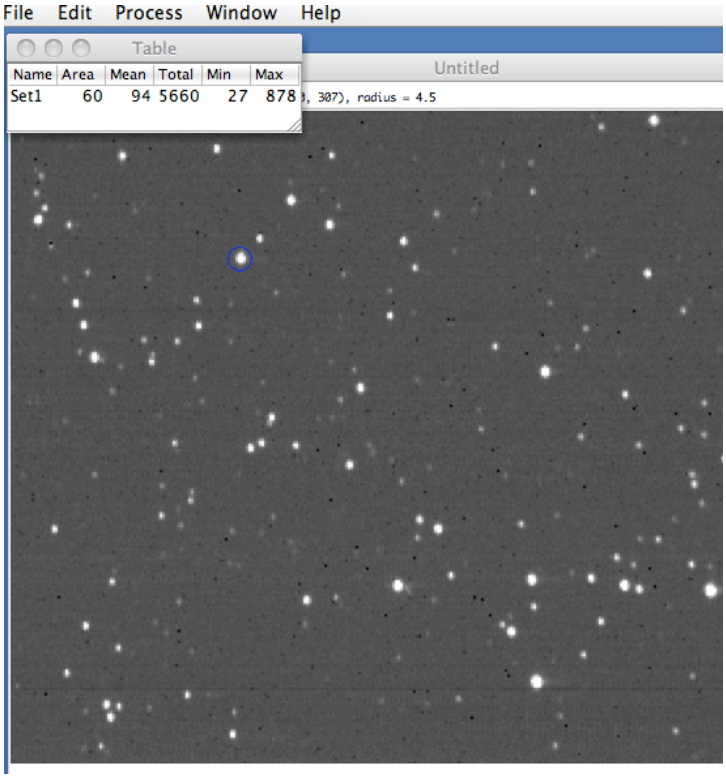


Click on the circle icon at the top of the image. Move the cursor so it is near HATP-10 and drag it to make a circle that is 4.5in in radius. This radius should be used for all measurements!

Adjust the location of the circle so it completely encircles the pixels of light associated with HATP-10. You can move the circle by dragging it or by using the i, j, k, and l keys (i=up, j=left, k=down, l=right).

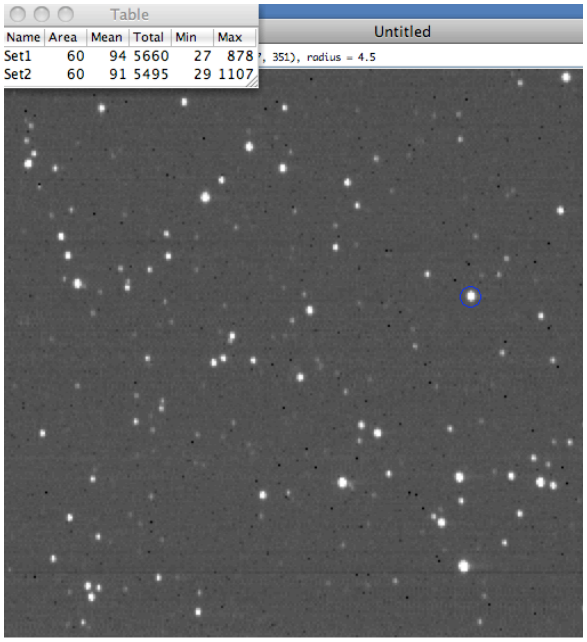


Hold down the “command/apple” m” on Macs and “control” “m” on PCs. A table is created at the top of the image with the brightness measurement.

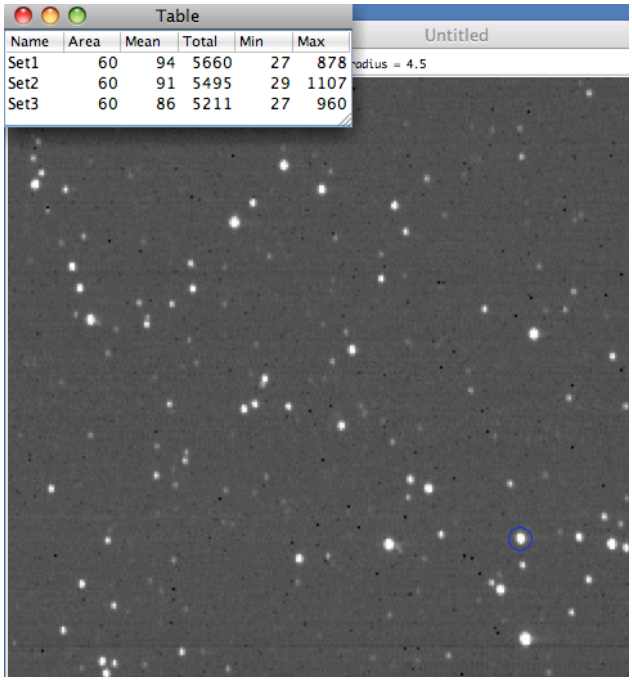


Step 4 – Measuring the brightness of comparison stars

Drag the circle to the first companion star, moving in a clockwise direction. Position the circle and take another image.



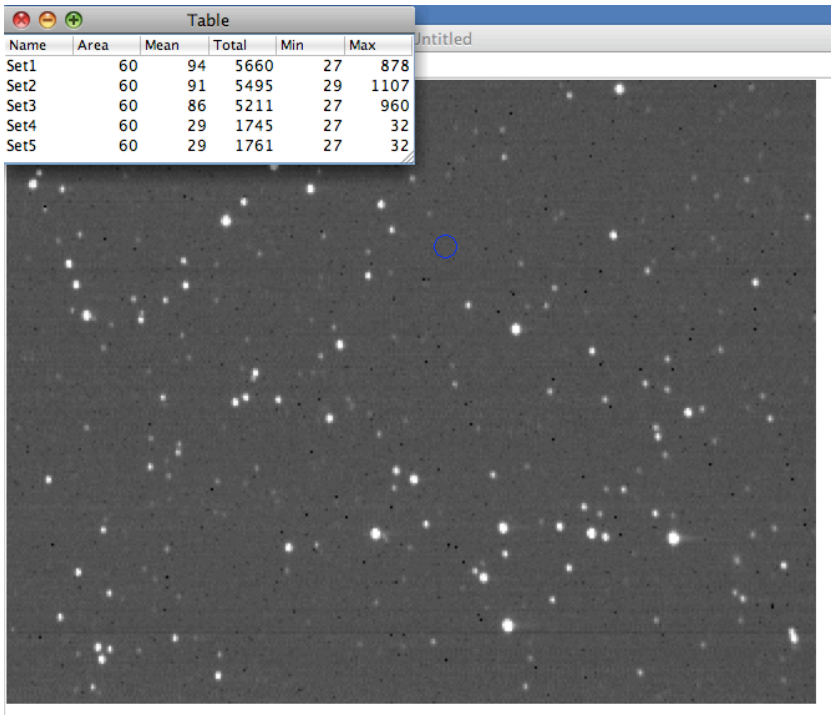
Repeat for the second comparison star.



Why am I doing this? Lots of things in nature can cause a star's brightness to appear to dim (for example clouds drifting across the telescope view). These natural occurrences should have the same effect on all of the stars in our field of view. If we assume that the comparison stars don't normally change in brightness due to transiting planets, we can compare the brightness of HATP-10 to the comparison stars.

Step 5 – Measuring the brightness of background sky

Repeat step 4 for two background locations. Select locations that are not on top of any stars.



Why am I doing this? The sky between the stars is not completely black. When you measure a star's brightness, you're actually measuring the brightness of the star plus the background sky. These background sky measurements will be subtracted.

All of the images taken in step 4 and 5 will be added to your table.

What does all of the information in the table mean?

Table

Name	Area	Mean	Total	Min	Max
Set1	60	94	5660	27	878
Set2	60	91	5495	29	1107
Set3	60	86	5211	27	960
Set4	60	29	1745	27	32
Set5	60	29	1761	27	32

Area = the total number of pixels in your circle
Mean= the average value for each of the pixels in your circle
Total= the total brightness of the star (or background)
Min=
Max=

Step 6 - Calculating the actual brightness of a star (the numbers you'll use to are the brightness measurements from column 4 Total)

a. **Find the average background sky**. First, find the average brightness of the background sky (add the two background measurements and divide by two.

(1761 + 1745)/2 = 1753

b. **Find the corrected brightness for each star**. Subtract this average background measurement from each of the three brightness measurements (HATP-10 and the two comparison stars)

5660 – 1753 = 3907
5495 – 1753 = 3742
5211 – 1753 = 3458

c. **Calculate the average correct brightness of the two comparison stars**. Add the two corrected brightnesses and divide by 2.

(3742 + 3458)/2 = 3600

Compare the brightness of HATP-10 with the average of the comparison stars by taking the ratio of the corrected HATP-10 brightness/average corrected comparison star brightness

What's your final measurement?

Compare your number to classmates and to the staff at CfA.
Now try this image of COROT2 and compare your results with ours!

Our results:

CoRoT-2100828063614.FITS

Set1 60 152 9154 107 603
Set2 60 134 8083 113 471
Set3 60 164 9861 0 1033
Set4 60 116 6989 105 122
Set5 60 117 7030 110 127

How did you do?