Day Assignment 4 solution

1) Find the “image” portrayed numerically in slide 27 of the Week 5 lecture notes. Assume this image is calibrated – flat fielding, etc. already completed.

a) By hand, measure the flux of the star (in units of counts) including your best estimate of the uncertainty in this measurement. What is the signal-to-noise ratio of the detection of this particular object?

b) Assuming the measurement is not influenced by read noise. Estimate the gain of this particular device by comparing the counts to the standard deviation in the counts (away from the star!).

a) You need to find the star (near the center of the frame (peak counts 102)) and decide how big an “aperture” you need to encompass all of the detectable stellar flux. Don't go too big with the aperture or you will capture additional noise without adding to the star's total counts. The green circle at right looks like it captures all of the stellar flux and encompasses nine pixels. The area between the red and green apertures defines an annulus in which background most appropriate to the star can be estimated. The star aperture contains 9 pixels so the stellar flux will be the sum of those pixels minus 9 times the average background in the annulus. The annulus contains 36 pixels where the mean is 17.6 with a standard deviation of 1.8 and thus a standard deviation of the mean (dividing by sigma by sqrt(36)) of 0.6. The sum of the nine “star” pixels is 355. Subtracting the background (9 * 17.6 = 158) gives a star flux of 197 counts. Assuming the noise in the detection is dominated by the background, we summed 9 things each with an estimated background uncertainty in each pixel of of 1.8 (given the single background pixel standard deviation above) giving an uncertainty in the total of sqrt(9)*1.8 = 5.4 and subtracted from that sum of nine times the background (and thus an associated uncertainty of 9 times the standard deviation of the mean of the background estimate – interestingly (expectedly) also 5.4. The total uncertainty in the difference between the star sum and the background estimate is sqrt(5.4^2 + 5.4^2) = 7.6. The signal was 197, so SNR = 197/7.6 = 26

b) The background mean away from the star (in the sky annulus) was 17.6 and the pixel to pixel standard deviation was 1.8. Gain = counts / (sigma)^2 so here gain=5.4 electrons/count.