PHY517 / AST443: Observational Techniques

Homework 3

1. Review the slides for lecture 3 & 4.

   (a) *(1 pt)* Post a question about the lecture material to #lectures.

   (b) *(1 pt)* Try to answer one of the questions in #lectures (more than one answer per question can be given!).

2. For the following, prepare a jupyter notebook in the format that you will use for the Lab 1 report. This means that you should describe what you are doing in a markdown box, followed by (a) code box(es) and their output (plots, print statements with the answer). Note that we do not want to read your code to figure out what you did - you need to document what you do in the markdown boxes. Do not submit the notebook itself, but "print" a pdf from it.

   (a) *(2 pts)* Generate 10,000 random numbers according to a Gaussian distribution with a mean of 1000 and a standard deviation of 10 (in python you can use the `np.random.normal` function). Plot a histogram of the generated values.

   (b) *(2 pt)* Read out the bin centers (x) and the bin counts (y) of the histogram (`plt.hist` or `np.histogram`). Note that the uncertainty on the counts y in a given bin is simply $\sqrt{y}$. Overplot them on the histogram.

   (c) *(4 pts)* Fit $y(x)$ with a Gaussian (`scipy.curve_fit`). Make sure to include the uncertainties on y in the fit. Overplot the best-fit Gaussian on the histogram and points.

   (d) *(2 pts)* Also compute the mean and the standard deviation of your data. Does your best fit agree with them within its uncertainties?

3. Look up the dark current (at 0°C) of the ZWO ASI 2600MM DUO camera, as well as the gain (units of e^-/ADU) assuming a "gain setting" of 0 (this information can be found on the Observing Equipment wiki page). Assume that the bias level of the camera is $\sim$ 100ADU.

   (a) *(2 pts)* In a dark frame of 2 minutes duration, obtained at 0°C, what will be the typical count level?

   (b) *(2 pts)* You take a 2 minute exposure of the sky, obtained at 0°C. On one pixel, you measure a total of 10,000 counts. How many photons did the CCD register in that pixel?

4. *(5 pts)* Complete the homework assignments from Tutorial 4.

5. Here, we will do basic photometry by determining the number of photons detected from a star, and using the known magnitude of a reference star to find the target star's magnitude. For the following, use "your" science frame from Tutorial 4.

(a) *(1 pt)* Open the header to find out the gain.

(b) *(2 pts)* Open the image in ds9 and identify the star at (300.236734, +22.658612). Draw a circular region around it that encompasses all the light from the star. Double-click on the region, and in the pop-up frame select "Analysis" and then "Statistics", which will show you a number of statistics of the pixels within the region. Consider which statistics are relevant for determining the flux from the star, and report them.

(c) *(2 pts)* Draw an "Annulus" Region around the star (avoiding light from any objects). This region gives you an estimate of the background counts. Consider which statistics are relevant for determining the flux from the star, and report them.

(d) *(4 pts)* How many photons from the star did this image register?

(e) *(3 pts)* Repeat these steps for the star at (300.237300, +22.846978), which has a magnitude of $R = 7.50$. Given this information, what is the magnitude of "your" star?