ASTR 337: Homework 7

Due Date/Time: Beginning of class (7 pm), Wednesday, November 6th 2019

Problems

1. Chromey 9.3 -- Centroiding Exercise
   (Submit via Moodle: either attach an Excel spreadsheet to your submission or provide a link to a Google Sheet.)

2. In a Jupyter Notebook, write **your own python function** to register (align) images based on the centroid of a selected star following the technique outlined in Chromey Section 9.4.1 and that you executed for Problem 1. Your code should take in a list of images and a region of the file in x,y coordinates (e.g., of the form [y1:y2,x1:x2]) and should output a list of shifts relative to the original image. In practice, your code should trim each full image to the sub-array carved out by the coordinates you specified (*hint: a good check would be to use plt.imshow to display one or more of these subarrays - make sure there's actually a star at the center!*). This region should be chosen to be approximately centered on a star, should contain no other stars, and should be at least 50 pixels square. Your code should then loop through these sub-arrays and calculate the centroid of each. To calculate offsets, you need to choose some reference point to register against; in this case, we'll use the first reduced B-band image of the Dumbbell Nebula, a.k.a. M27 or NGC6853 (fdb_20190918.00000063.NGC 6853.fit) so we can compare to the results from using cross-correlation in Lab 6. Apply your code to your reduced V band images (#68 to #72) of the Dumbbell to calculate the centroid shifts for the 5 V-band images relative to the reduced B-band image. Submit your notebook via Moodle, along with your answer to Problem 3 below.

3. Compare the shifts you calculated in Problem 2 with the shifts you calculated in Lab 6, which used the cross-correlation method to align all of the B, V, and R-band images to that same first B-band image (fdb_20190918.00000063.NGC 6853.fit). Quantitatively, how are the shifts computed by the centroiding and cross-correlation techniques different?

Pre-Lab Reading and Questions for Week 8

Reading

Please read the following in Chromey:

- Chapter 2 - *Uncertainty*

Reading Questions

1. Describe the distinguishing features of and differences between the Poisson and Gaussian distributions.
2. How are the Gaussian and Poisson distributions related to the central limit theorem?
3. Describe standard deviation - how is it calculated and what property of a statistical distribution does it capture?
4. Describe in your own words how signal to noise is calculated from an astronomical image.
    a. How does this value change as number of images is increased?
    b. How does it change as exposure time is increased?
5. Describe the relative advantages of mean, weighted mean, and median combination.
6. What does it mean to “add uncertainties in quadrature”? How might the examples described in Section 2.5.1 be relevant for us when we construct color-magnitude diagrams for stars in clusters?