ASTR 337: Homework 2

Due Date/Time: Beginning of class (7 pm), Wednesday, September 18th 2019

Problems

1. From Chromey: Exercise 1.7 (“The bolometric flux from a star…”)

2. From Chromey: Exercise 1.9 (“A double star has two components of equal…”)

3. From Chromey: Exercise 1.13 (“Derive the distance modulus equation in Eqn. 1.25…”)

4. Programming exercise on cluster distributions (submit via Jupyter notebook in Moodle):

Recall that galactic coordinates (*l, b*) of an object locate it in the following reference frame:
• fundamental plane: plane of the Milky Way
• origin: the Sun
• galactic longitude *l*: wraps 360º around plane of the galaxy; *l* = 0º toward the galactic center
• galactic latitude *b*: extends ±90º up to the north and south galactic poles.

The galactic longitude and latitude for 398 open clusters from an article by Ahumada and Lapasset (1995) and for 111 globular clusters from Harris (1976) are posted on the course Github page (https://github.com/spacegal-spiff/AST337-Fall2019) in the Homework02 folder. They are named, respectively, *galactic.open.dat* and *galactic.glob.dat.*

NOTE: Coordinates for open clusters are in the order *l, b* while for the globular clusters they are *b, l.*

a. Download the two data files for open clusters and globular clusters and read the data into python using pandas.
b. Make two plots, one showing the distribution of open clusters and one showing the distribution of globular clusters. Each plot should have galactic longitude *l* on the X-axis, with limits from −180º to +180º, and galactic latitude *b* on the Y-axis, with limits from −90º to +90º. Use identical limits for both plots, and be sure to label your axes and units. On each plot identify the location of the galactic plane and the galactic center.
(Note: You will have to convert the longitudes from 0 to 360º to -180º to + 180º)
c. Carefully **describe** the distribution of open and globular clusters, discussing their similarities and differences in both (1) galactic latitude and (2) galactic longitude. What are the implications of these distributions? Answer as quantitatively as possible.

Some suggestions for Problem #4:

Reading in Data

To read in the data for the cluster distribution plotting exercise, you may find that our usual pandas approach, *pd.read_csv*, has some difficulty parsing the data. In the past labs we have used comma or semicolon delimited data, but the .dat files you're working with in this exercise are space delimited. Furthermore, the headers and data in the .dat file columns from these two studies are not necessarily separated by the same number of spaces -- and *pd.read_csv* struggles with this.

Helpfully, pandas has a large number of different methods to read in data. Since our data files are separated by spaces in such a way that the columns align with each other, the one that's easier to use in this case is called *pd.read_fwf*, with "FWF" standing for "fixed-width format". No additional arguments are necessary, e.g.,:

```
globulars = pd.read_fwf('galactic.glob.dat')
```

We will encounter many different types of data formatting throughout the course, e.g., tab delimited data (`pd.read_csv('file.dat', delimiter='\t')`) but *pd.read_fwf* is now a new tool in your data-handling toolbox! You can see more methods like it in Jupyter by typing *pd.read_* then hitting the tab key.

Plotting Longitude

Note that we want to plot the longitude from -180º to +180º, in order to visualize looking toward/away from the galactic center (much as we see the plane of the galaxy). This means you will have to manipulate the existing longitude arrays such that any value > 180º has the correct negative value.

There are a few different ways to accomplish this. One approach involves a useful numpy function to identify particular values in an array, called *np.where* (more information can be found in the numpy documentation online and StackOverflow has examples). We will be making use of this function later in the semester as well, when we get to manipulating CCD image data.

In order to use *np.where*, you may have to convert your pandas series to a numpy array first, e.g.,:

```
globular_longitude = np.array(globulars['LONGITUDE'])
```

https://stackoverflow.com/questions/34667282/numpy-where-detailed-step-by-step-explanation-examples/34667386#34667386

Pre-Lab Reading and Questions for Week 3

Reading

Please read the following sections in Chromey:

- Chapter 5
- Chapter 6 through the end of section 6.2

Questions

1. Pick the three terms from the list in the first bullet of the Summary on page 146 with which you are *least familiar* and describe them as you would to a peer.
2. What is atmospheric dispersion, how might it manifest itself in an astronomical image, and for what wavelengths and elevations in the sky do you need to correct for it?
3. Describe the relationship between the Airy pattern and the diffraction limit of a telescope.
4. For what type of telescope is chromatic aberration a concern?
5. Where in an image does one worry about spherical aberration and where do aberrations like coma and astigmatism come into play?
6. Describe one advantage and one disadvantage of each type of telescope mount (altaz and equatorial).
7. Write down three important/main points from this week's reading and define them in your own words.
8. What concepts did you find unclear in this week's reading?