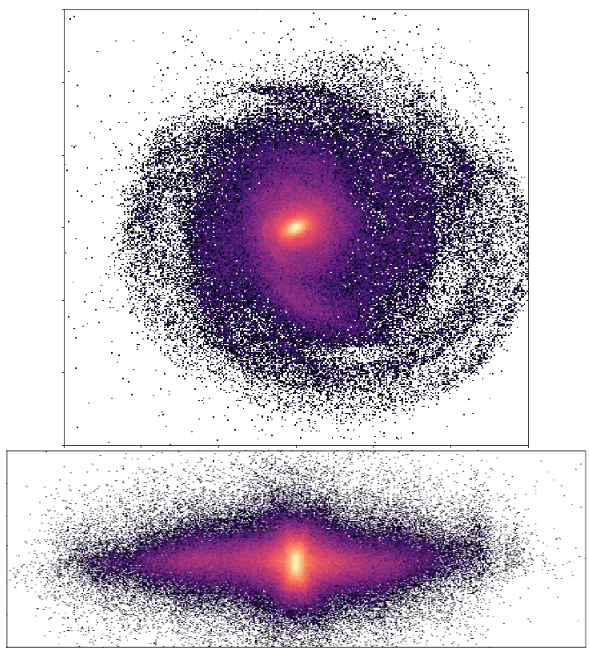
ASTR 400B In Class Lab 5

Feb 15th 2018

The goal of this lab is to make density plots of a high resolution simulated Milky Way disk.



1. Update your clone of the Class Github Repo (git pull)
2. Under InClassLabs/InClassLab5 you should find a template jupyter notebook and script called 'Feb15_Template'. These templates include the same instructions as those provided below.
3. There is also a file called MW_HR_000.txt, which is a higher resolution of the MW file you have been working with in previous assignments. All columns are the same as in previous data files but the particle masses will be smaller.
4. InClass5_Slides.pdf contains some observational data plots that will be used for comparison later.

1 Part 1

- The template creates a CenterofMass() object and uses that to calculate the position and velocity COM of the disk particles.
- The x position of the particles in this file have already been defined for you. Define the remaining position and velocity properties.

2 Part 2

- What two position components need to be plotted to get a face-on disk?
- Use the pyplot hist2d() function to create a binned 2D histogram of the MW's disk face-on. Start with bins=100.

3 Part3

- Add the norm=LogNorm() argument to the hist2d function. The colorbar should now appear in logarithmic units. What does the colorbar represent?
- Now increase the number of bins to get a higher resolution plot.

4 Part 4

- Create a plot of the MW's edge-on disk. What two position components should you plot against each other?
- Use hist2D with a large number of bins and the norm=LogNorm() argument again.

5 Part 5

- Does the densest part of the MW disk in your face-on and edge-on plots reside at position=(0,0)? Re-center the particles to the center of mass using COMP. You can do this by changing the quantity COMP back to floats by doing the following to all position particles:
  xD = COMD.x - float(COMP[0]/u.kpc)
- Repeat the above for the velocity components using COMV now. Be careful with units.
- Recreate the two plots using the center of mass reference frame.

6 Part 6

- We will now make a phase diagram and compare it to the calculated circular velocity of the MW's disk assuming spherical geometry.
- If you look at the MW's disk along the y-axis, what velocity component will give you the line of sight velocity? Use your intuition from the edge-on disk plot above.
- Use hist2d again to plot the y-position of the disk particles against this velocity component.
- Compare your plot to the plots in InClass5.pdf. Does your plot match the observational data?

7 Part 7

- Now overplot the MW's circular velocity computed with the CircularVelocityTotal() against the radius array. These are already defined as 'VCirc' and 'R' above.
- Notice the axis limits of the y-axis above. Hint: If you have an array called X, then -X will multiply the whole array by -1.
- How does the phase diagram compare to the spherically averaged circular velocity? Why is there a spread in velocities?

8 Part 8

- Let's isolate an interesting set of particles and explore their origin. This may be helpful to many of your for your final projects. For example, where do the particles with the highest speeds reside and why do they have such high speeds?
- Create a velocity mask that selects all particles from the plot above that have a velocity of 250 km/s or higher. Note that these velocities can be positive or negative.
- Using the plotting code for an edge-on disk plot, plot just the particles with the highest speeds.
- How did these disk stars arrive at this position?