Homework 4

Destroy this Cluster

This week your job is simple: take the cluster you lovingly studied in Homework 2 and destroy it (i.e. turn it into a tidal stream).

The first goal of this project is to familiarize yourself with one of the emerging standard packages for simple dynamics and orbit calculations. I suggest using **Gala**. I am sure you could also do this quite easily with **galpy.** Other good packages might exist, and you are free to use them if you like!

The second goal is to explore the differences between a Milky Way like galactic potential and a dark-matter only one.

Part 1: Setup

(10pts)

1.1. Install a Galactic Dynamics Package
I suggest using **Gala**. I am sure you could also do this quite easily with **galpy**.

Hopefully this is a simple "pip install" and you can move on to the next part!

1.2. Establish the 6D coordinates for your cluster
To plot the orbit of your cluster you are going to need to know the full 6D phase space coordinates: RA, Dec, Distance, pm_RA, pm_Dec, Radial Velocity

The first 5 coordinates should have been used in Homework 2 (and probably can be found easily on Simbad or in a paper via a quick Google or ADS search).

Radial Velocity for the cluster (*not* for individual stars) will be needed to complete the coordinates! For many clusters this might be listed on Simbad. Or seriously just try Googling "Radial Velocity NGC XYZ".

Part 2: Orbit!

(40)

Your goal is to try and turn your cluster into a tidal stream. This might work very easily for some clusters based on their orbits, and for some it might never work. I heave no idea how many orbits it will take, or how many knobs you'll have to tune… I promise nothing!

As always, you get no points for the "right" answer and full points for critical thinking.

I can imagine two straightforward ways to create a tidal-stream like structure:

1. If using Gala, simply use the **MockStreamGenerator** function, which applies some generalized stellar ejection rules to create a stream.
2. If using Gala or galpy, integrate the orbit of your cluster in the galaxy 100 or 1000 times, but adding small Gaussian offsets to the 6D phase space conditions. Gala has **an example** of doing this kind of approach as well.

There may be other clever ways to approximate or model a tidal stream. Neither of these tools handles proper N-body approaches (I believe), but that would be another excellent method (i.e. create a cluster of a few thousand individual particles and let them orbit the Galaxy).

2.1. Create a tidal stream using a Milky Way like potential

This potential model needs to include at least a disk and halo component. If you're using Gala you can (should) easily use the pre-packaged **MilkyWayPotential**, or build your own (useful if you want to make e.g. a heavier disk, etc).

Does the cluster quickly disrupt (i.e in a few orbits?) How large does the stream get?

2.2. Create a tidal stream using a large NFW potential

Using the same initial 6D conditions as the MWY potential above, and hopefully a similar total Galaxy mass, try and generate the tidal steam as before with a simple NFW potential.

Does the stream form? Does it form as quickly (i.e. in the same number or orbits)?

Be sure to have some nice plots showing 2D or 3D projections of the orbit or stream. Some comparisons between the MWY and NFW results would be good. **Tell me what you find!**

Turn In

Use this Dropbox Link to turn in a PDF of your write-up.

This could simply be a saved Jupyter notebook with lots of annotation/discussion, or could be formatted in LaTeX with embedded figures. Remember to **show your work**, meaning the provenance of your data and the decisions you've made to create your figures.

Collaboration is encouraged for problem solving. Please list clearly all your collaborators! Each person is responsible for turning in an obviously unique work product (i.e. you write your own code, your own discussion, etc). This is a graduate course: I don't care about you getting the *right* answer as much as I want to see the efforts of your thoughts and synthesis!

Nominal Due Date: 2023-03-03