1. Define The proposed Topic:

Tidal Transformation of Satellites: Evolution of the internal stellar structure and dynamics of M33 and mass loss rate. As the two galaxies merge with each other, we plan to research and see how stellar evolution and mass losses of stars located in M33 changes after the collision.

2. State why this topic matters to our understanding of galaxy evolution.

While we understand how stellar evolution, structure, and dynamics work it becomes tricky under extreme circumstances. One circumstance is galaxy merger. More specifically, we see more of the “rare” cases when it comes to stellar dynamics. This also helps us understand how the density of the galaxy changes as well as the evolution of the galaxy as a whole.

3. Overview our current understanding of the topic.

We currently understand the general shape of the galaxy and the types of stars that exist in certain locations. In specific, the stars at the center of the galaxy tend to be newer and are richer in metallicity, while stars on the outer rings are older and have metal-poor. Over time, the data showed that star formation in the inner rings started before it did in the outer. (https://academic.oup.com/mnras/article/410/1/504/1035281)

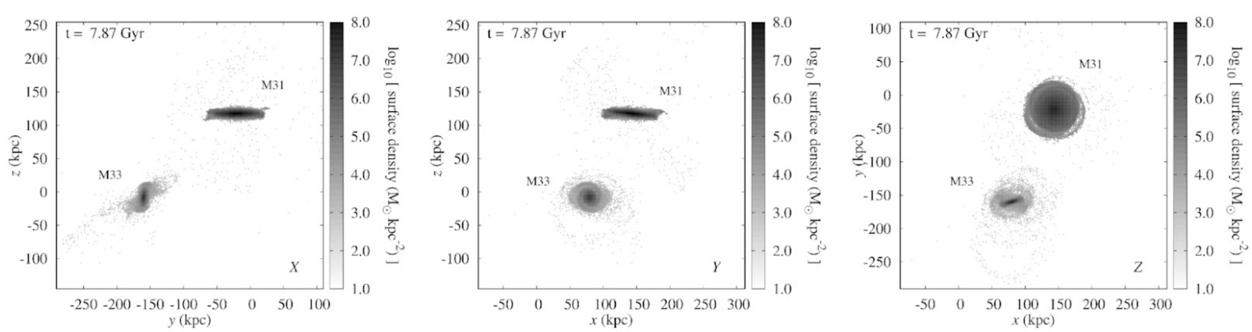
For M33, we know that it is preferred to use molecular-hydrogen-correlated star-formation law for the m33 disks, especially factoring in the radial distributions of the different types of stellar populations. We also know that accurate models following a moderate outflow rate and an inside-out formation are shown to reflect our observations for this galaxy. (https://academic.oup.com/mnras/article/426/2/1455/975237)

The M31 and M33 tidal interactions show that even if the two galaxies are within 50kpc, that tidal interactions do not produce structure reminiscent of stellar streams. We also know that there is a tidally induced gas around the two galaxies, and a diffuse gas stream. We also see both these galaxies embedded in a diffuse background medium. (https://academic.oup.com/mnras/article/493/4/5636/5721546)

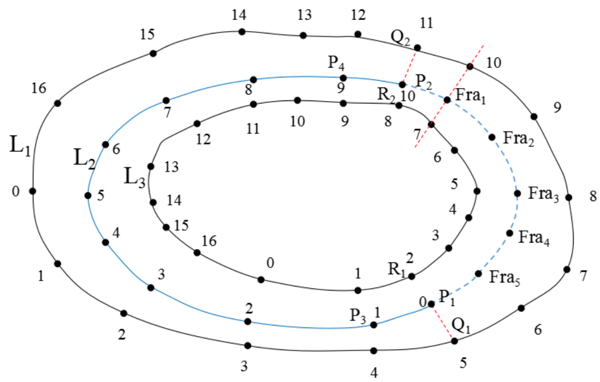
4. What are the open questions in the field?

Most studies noted that the models are fairly accurate, but not pinpoint accurate. This includes assumptions made such as lower resolution models, models that have higher flow rates of particles into the galaxy, and more.

6.



The Proposal
1/
The three question I would like to address are
1)How does the velocity dispersion of the stellar particles evolve?
2) Is m33's disk turning into a spheroidal system?
3)how does M33's stellar rotation curve evolve?
2/
To solve the three questions, we need to devise multiple separate codes for different purposes. First, we need to get a piece of code that requires us to extract the data of M33 over time. Since all the data is given to us, we simply have to organize it the way we want. We already have a class code for this. This data extracted has multiple things to it. Firstly it has the x,y,z positions of all the particles in that galaxy, their velocity in x,y,z terms and their masses. We need to write a code that gets each velocity of each particle, gets their standard deviation (or dispersion). Then, after doing that for one time, we need to elongate that time and get it for the different times. For each file we have (different amount of times passing) we plot the data and get the dispersion versus time graph for the first question.
In solving for if the M33 disk is turning into a spheroidal system, we can use contour lines (as discussed in class how to) to get a general shape for the galaxies. Once we have the shapes, we can roughly compute their eccentricity by getting the center points of the galaxy, taking the distance the disk is away from that center in 4 directions and solving for the eccentricity. We can take the eccentricity of the data for one instance of time, then compare it to the rest of the data set. We can then see how eccentricity changes through time. Another way to confirm this is by direct modeling and observation. By taking multiple images with the contour lines and comparing them at different times we can qualitatively guess how the disk is turning into a spheroidal system.
Finally to see how M33's stellar rotation curve evolves we can take our given data in one instance of time and see its rotation curve. To do this, we can by taking our given values of velocity and distance (both will be radial) and draw a plot. If we do this in more instances of time we can see how the velocity curve changes, however, this is not the best solution. Instead we can use interpolation methods to get a smoother line. Once we get this line, we can take a contour of the other time instances. By slightly changing the color hue as time goes on, and stacking each graph on each other, we can obtain a plot on how the graph changes over time on a single graph. We can further get an analytical result by taking the different of each contour line and seeing how the difference changes with respect to time.



For the sake of argument, take this visualization of 3 different data points. If these are the “lines” (these are circular so they won't be) in our data, we can see how having multiple of them will have an arrow pointing to them or the color changing or our analytical result giving us a value.

4. Hypothesis.

1) I think the velocity dispersion of the stellar particles will get larger as time progresses. Since at the beginning everything is compact, a lot of the particles will be compressed and their deviation from the average velocity will be less, however, as the galaxy expands and gets larger, its velocity curve gets the shape we know most galaxies have. This shape has a large deviation from the average thus meaning that the velocity dispersion will also increase as time progresses.

2) I believe that m33 is going to turn into a spheroidal system. This is because over time similar galaxies, like M31, turned into a spheroidal system thus it is likely that the satellite galaxy of M33 can also turn into a spheroidal system.

3)Over time, I think that the velocity curve will get more round. I think that at the beginning of the galaxy, a lot of the stars will be more compact, allowing the rotation curve to be “smoother”, thus as time progresses we might observe the curve stabilizing faster, thus having the more apparent shape we are familiar with. However, I do not think that this is going to be by a lot.