ASTR 400B Research Assignment 4

Due: April 6 2023, midnight

In this assignment you will refine your proposal from Assignment 2 to the format needed for the final paper for 3 sections: Introduction, Define Your Project, Methodology.

The instructions continue to describe a Results and Discussion section. These are not required for Assignment 4, but will be due for Assignment 6.

The primary goal of this assignment is designed to keep you on track to finish the course. This assignment will not be graded.

1 General Expectations for the Final Report

The below refers to the *final* report, but these guidelines should be adhered to for this assignment as well.

- The final report is 30% of your final grade.
- The report must be written in LaTeX using ApJ or MNRAS formatting (double column). You can find templates on overleaf.
- The final report is not to exceed 5 pages in ApJ or MNRAS format (not including figures) but must be at least 3 pages (not including figures). For this assignment, you should aim for 2 pages (with figures, excluding results).
- Note, Plagiarism will result in a grade of 0.
- Proofread the text! Grammar is part of the grade for the final report.
- All papers must be properly cited using BibTex. Citations must appear as a bibliography at the end of the document. There must be at minimum 3 refereed papers cited.
- Follow the below outline (section headings and content guidelines). This is how I will grade your paper. Each heading refers to a heading or component that is expected in your report.

2 The Report Outline

2.1 Title

Include a descriptive title that relates to the question you are trying to answer. Below the title, you must include your name and the submission date.

2.2 Keywords

The ApJ or MNRAS LaTeX templates allow "keywords" to be defined. Your report must include **at least 5 keywords** selected from the below list. You must list these at the top of the report (ideally in the keywords location in the ApJ/MNRAS template file).

When you first use a keyword in the main text, you must *define* it. A definition can be an equation.

Proper Motion •Local Group •Stellar Disk •Stellar Bulge •Major Merger •Minor Merger •Dry Merger •Dynamical Friction •Jacobi Radius •Tidal Stripping/Sharing •Quenching •Late Type Galaxy •Early Type Galaxy •Spiral Galaxy •Elliptical Galaxy •Flocculent Spiral •Tidal Tails •Tidal Bridge •Hierarchical Growth •Cold Dark Matter Theory •Hernquist Profile •Satellite Galaxy •Dark Matter Halo •Halo Spin •Halo Shape •Red Sequence •Blue Cloud •Green Valley •Rotation Curve •Dispersion Supported •Velocity Dispersion •Virial Equilibrium •Virial Radius •Gravitationally Bound •Galaxy Interaction •Galaxy Merger •Merger Remnant •Kennicutt-Schmidt Relation •Star Formation Main Sequence •Star Burst •Local Standard of Rest Velocity •Disky/Boxy Isodensity Contours •Rapid/Slow Rotator •Baryon Fraction •Sersic Profiles

2.3 Section: Introduction

Edit your introduction based on the comments you received from Prof. Besla. Your Introduction must be written in the style of an introduction to a paper. The introduction is expected to be at minimum 1 page, double column in ApJ/MNRAS format. You must follow the below outline

1. **Paragraph 1:** Introduce your topic (as defined under "assigned topics" in the instructions for Assignment 2). This does not mean write "My project is to ..". Instead, if your topic were e.g. the evolution of SMBHs, you would write "Super Massive Black Holes (SMBHs) are believed to reside in the center of massive galaxies" . I.e. **define** the topic and associated broad concepts in galaxy evolution (e.g. dark matter halos, tidal tails, Local Group - see keywords).

2. **Paragraph 2:** Explain why your topic matters to our understanding of galaxy evolution. You must define the terms "galaxy" (Lecture 1, Willman & Strader 2012 AJ) and "galaxy evolution".

3. **Paragraph 3:** Explain what we currently know about your chosen topic. Papers must be cited in this paragraph. A figure must be referenced within the text to help explain something learned about the topic (what the topic is or why it matters).

4. **Figure 1:** The figure should be a paper from a refereed journal paper that illustrates something we have learned about the topic. The figure must have a caption that includes the paper citation and describes everything that is plotted. This **cannot be verbatim** from the original paper. The caption must finish with the punchline for the figure - what should the reader take away from the figure?

5. **Paragraph 4:** What are the open questions in your chosen topic area (as defined in Paragraph 1)? One of these open questions must relate to your specific project. How are people trying to solve these questions? You must include citations.

2.4 Section: This Project

1. **Paragraph 1:** Introduce your **specific** project. (e.g. "In this paper, we will study the change in position of the SMBHs of the Milky Way and M31's throughout the future collision and eventual merger of these two galaxies"). This isn't supposed to be general. Be as specific as you can be.

2. **Paragraph 2:** Which of the open questions (paragraph 4 of the intro) does this project address?

3. **Paragraph 3:**Why is this open question an important problem to solve for our understanding of Galaxy Evolution? How will your study help us to address the open question?

2.5 Section: Methodology

1. **Paragraph 1:** Start with an introduction to the simulations you are using. You must reference the paper and describe what is meant by an "N-body" simulation.

2. **Paragraph 2:** Overview your approach. Discuss a figure (Figure 2) to explain what you are trying to do.

3. **Figure 2:** This figure can be from a published paper or can be a detailed diagram you created to describe your logic. The figure must have a caption, follow guidelines listed for Figure 1.

4. **Paragraph 3:** Describe the calculations your code will compute. You must include all relevant equations and citations, and describe the meaning behind every parameter in the equation (e.g. The circular speed is defined as $V_c^2 = GM/r$, where M is the Mass of the host galaxy ($M_\odot$) and r is the Galactocentric radius (kpc)). Note that the reference for the Hernquist profile is Hernquist 1990 ApJ 356.

5. **Paragraph 4:**: Describe the plots you will need to create and explain why those plots will answer your question. Note that later your results section must feature at least two figures that you created. One Figure can be generated entirely by code from Homeworks or In Class Labs (e.g. phase diagrams, density plots). The other figure must be generated by code that includes one new function or method that YOU created BY YOURSELF.

6. Note: You do not need to describe in detail what your code is doing - this must be done in the code itself (see Code Requirements). However, you can include a figure to describe a flow chart for your code logic if that helps to explain your methodology.

7. **Paragraph 5:** Describe your hypothesis for what you think you will find. Explain your motivation for this hypothesis.

2.5.1 Code Requirements

1. For this assignment, code does not need to be complete. The next code Check in will be April 18th 2023.

2. Code must be documented, with each step outlined and all parameters defined.

3. Equations must have references to papers if applicable.

4. Code can be largely based on Homework Assignments and In Class Labs, but there **must be at least one function or method that you created by yourself.**. Indicate this new code in the code documentation.

5. Your code(s) must generate 2 figures (one created using your new function or method)

6. Code must be uploaded to Github

2.6 Section: Results (Not required for Assignment 4)

Here is where you will report on progress. If your code is far enough along at this stage, you can start this section. If you don't yet have results, you can leave this alone for now. It will be required for Assignment 6.

1. **Paragraphs 1 and 2:** Describe each of the two figures (Figures 3, 4) that you have created from your code. One paragraph per figure. End each paragraph with the main take away result.

2. **Figure 3:** This figure can be generated entirely by code from Homeworks or In Class Labs (e.g. phase diagrams, density plots).

3. **Figure 4:** This figure must be generated by code that includes one new function or routine that YOU created BY YOURSELF.

4. Each figure must have a detailed caption where everything plotted is explained, including axis labels. Include in the caption a punchline for each figure that explains what the reader should take away.

2.7 Section: Discussion (Not required for Assignment 4)

1. **Paragraph 1:** Summarize one result. Does this result agree or disagree with your hypothesis? How does this result relate to existing work in the literature? What is the importance/meaning of this result for our understanding of galaxy evolution?

2. **Subsequent Paragraphs:** Repeat the above if you have a 2nd result (etc.)