Project Plan: Computational Astrophysics and Dark Matter

Fall 2016 – Spring 2017

Research Team

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Student Name, Aresty Research Assistant (student email)

Learning Goals

Broad goals for the Aresty Research Assistant Program

- Develop problem solving skills in research environment
- Learn to communicate research to diverse audiences
- Build confidence in the social environment of research

Specific Goals for this Project

- Gain experience with the computational tools used by astrophysicists
- Develop Python software for gravitational lensing
- Use the software to analyze observational data and probe the distribution of dark matter around galaxies

Description of Project

Many lines of evidence indicate that the universe is dominated by two invisible, exotic substances: dark matter forms the scaffolding for the visible universe, while dark energy causes the expansion of the universe to accelerate. Together, dark matter and dark energy account for 95% of the content of the universe. Cosmologists face a conundrum: how can we study substances we cannot see, let alone manipulate? A powerful approach is to observe objects whose motion is influenced by gravity. The principle of using motion to study mass has been applied to planets, stars, galaxies -- and even light itself. We see hundreds of cases where the gravity of a distant galaxy acts as a sort of lens, distorting our view of a more distant object. To interpret observations of "gravitational lensing," we use specialized computer software that lets us simulate the light bending and develop models that match the data.

In this project we will work with the computational tools that astrophysicists use to analyze gravitational lensing and investigate dark matter. The goal is not only to produce a valuable software package but also to understand how the software supports the overall quest to understand dark matter.

Student Responsibilities (minimum 5 hours per week)

A principal aim for this project is to deploy a Python package for gravitational lensing research. A package is based on existing software written by Professor Keeton. Our goals will be to translate some of the core routines from C into Python, develop an effective user interface, and then apply the new Python package to data from astronomical observatories (including the Hubble Space Telescope). The team-based approach will give students plenty of opportunities to suggest and implement their own ideas for the astrophysics software package.

Required Readings and Meeting Schedule

We will meet as a group once a week, plus extra times as needed.

- In Fall 2016, we will meet on Wednesdays from 3:30-4:30pm
- In Spring 2017, we will determine the meeting time based on our schedules