

PHY494 Final Project Proposal – Simulating dark matter's Influence on a typical galaxy

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Problem

Since the early 1900's astronomers have made various observations that posit the existence of an unknown massive substance. This 'dark matter' has not been directly detected by through its influence on visible matter, it's presence is only known through indirect approaches such as its gravitational effect on visible matter. One problem explained by dark matter has to do with the orbital velocities of galaxies. Using Newtonian gravity, the orbital velocity of matter in a galaxy should decline with distance from the center. This is similar to the motion of the planets in our solar system. Observations, however, show that the orbital velocities of matter don't decline, they are relatively constant with distance from the center. If dark matter is spherically distributed throughout the galaxy the calculated orbital velocities match observation.

Approach

This project seeks to simulate a typical galaxy and compare the orbital velocities of matter in the galaxy both with and without dark matter. The simulation will use an approach similar to simulation of Neptune and Uranus. The simulation will use Newton's equation for gravitation, $F = \frac{GMm}{r^2}$, combined with the velocity verlet algorithm to solve this problem. The orbital velocities for the simulation and without dark matter can then be found using the equation $v^2 = \frac{GM}{r}$. The distribution of visible matter in the galaxy, the distribution of dark matter, the size of the galaxy, and the initial orbital velocity of the galaxy will be needed in order to accurately simulate the motion of the galaxy.

Objectives

The objectives for this project are below:

1. Obtain accurate size and mass distributions for visible matter in a typical galaxy.
2. Obtain plausible shape and mass distributions for dark matter.
3. Simulate the motion of a galaxy without the influence of dark matter.
4. Simulate the motion of a galaxy with the influence of dark matter.