CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
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Project Number
S1805

Project Title
Analyzing the Effects of the Andromeda Galaxy (M31) on Its Dwarf Spheroidal Galaxies (dSphs)

Abstract

Objectives/Goals
Many galaxies have smaller satellite galaxies orbiting around them, known as dwarf spheroidal galaxies (dSphs). Recent discoveries of new dSphs around the Andromeda Galaxy (M31) prompted me to understand the relationship between the dSphs' properties and their distances from Andromeda. I hypothesized that the dSphs closer to Andromeda would have greater mass-to-light ratios and greater radial velocities, but smaller masses.

Methods/Materials
I used the velocity data collected for many of the stars in each of four dSphs (And I, And II, And III, And VII). However, I first removed contaminant stars from Andromeda's halo. Using a program that runs Maximum Likelihood, a statistical method, I fit two Gaussian curves to the data, one for the dSph's stars and one for the halo stars. Using the velocity dispersion of the dSphs' stars from its Gaussian distribution, I got the radial velocity and calculated the mass and mass-to-light ratio of the dSphs.

Results
Comparing the radial velocity, mass, and mass-to-light ratios of the dSphs to their distances from Andromeda, I found that the radial velocity decreased as the distance from Andromeda increased. However, there was no direct correlation between the mass and the distance. Finally, I found a relationship, where the mass-to-light ratio decreased as the distance increased, but only if And III's data was ignored.

Conclusions/Discussion
The values that I calculated for radial velocities corresponded closely with previously published data, corroborating my conclusion that Andromeda's gravitational force has a direct impact on the dSphs' radial velocities. The correlation where the mass-to-light ratio increases as the distance decreases only exists without And III. This is because either And III's data is more prone to error or And III's small mass makes it an outlier. Furthermore, because mass-to-light ratios are directly proportional to dark matter content, this correlation proves that the dSphs closer to Andromeda and with a higher mass-to-light ratio have more dark matter. Based on current simulations of dark matter by various researchers, there should be many more dwarf galaxies than have been discovered. If the dSphs with the highest dark matter content are near Andromeda, then it is possible that the dark matter we are looking for has actually been assimilated into Andromeda through gravitational forces.

Summary Statement
I discovered the relationship between the Andromeda Galaxy and its dwarf spheroidal galaxies, which reveals an increasing density of dark matter closer to Andromeda.

Help Received
Professor Puragra Guhathakurta of UCSC provided the data and mentored me; my younger sister helped with my board