CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

S1803

Project Title

Identification of Satellite Galaxies around Milky Way Galactic Analogs Using Machine Learning Algorithms

Abstract

Objectives/Goals

The Milky Way (MW) is host to a population of two dozen satellite galaxies. However, observed properties of these MW satellites differ significantly from those predicted by the Lambda Cold Dark Matter Theory (LCDM), constituting the discrepancy at the center of the Dwarf Galaxy Problem. To investigate this discrepancy, we extend our cosmological context and study satellite populations of MW analog host galaxies within redshift < 0.01, selected to resemble the MW in luminosity and environment. Studying such analogous satellite populations and their properties will yield insight into their correlation with the LCDM model, which can be used to determine where and why the MW satellites break off with the LCDM model. A significant obstacle is the detection of these MW analog satellite galaxies against a large background of faint galaxies and stars: spectroscopic follow-up is expensive, and so accurate classification of satellite candidates based on photometric and morphological data is important.

Methods/Materials

We compile a machine learning training set containing photometric and morphological data for the MW analog satellite populations, and train a Neural Network (NN) and Support Vector Machine (SVM) classifier on a pre-processed version of the data set. We measure effectiveness of the algorithms in terms of purity and completeness of classification.

Results

Through a series of experiments with the classifiers, we find the SVM to achieve 93% completeness and the NN to achieve 97% completeness for a fixed 10% purity. We also find the photometric data to be the most informative in classification.

Conclusions/Discussion

We thus present a more accurate method of identifying MW analog satellite galaxies among a large sample of background galaxies, a major stepping-stone in solving the Dwarf Galaxy Problem.

Summary Statement

My research presents a new method to identify pure samples of Milky Way analog satellite populations with accuracy in identification of 97%; this method can be used to solve the Dwarf Galaxy Problem.

Help Received

This research was conducted at the Stanford University astrophysics department, where I worked under the guidance of a professor and two postdoctoral fellows. I received guidance from my professor throughout the project and help from the postdoctoral fellows in learning necessary techniques.