Classification of the Milky Way's Dwarf Spheroidal Satellite Galaxy Candidates through Machine Learning

Yoo, Seung Jean (School: West High School)

Dwarf spheroidal satellite galaxies (dSphs) around the Milky Way are the best approaches to dark matter(DM) search and study. They can ultimately provide insight into the merit of the Cold Dark Matter model, the hierarchical merging history of galaxies, and the properties of DM. Yet, it is currently difficult to detect new dSphs because of their faint luminosities. Therefore this project took a machine learning approach to detecting new dSphs around the Milky Way. Specifically, it relied on the distinctive pattern in the Color-Magnitude Diagrams (CMD) of known dSphs, seen in existing literature. Data from Gaia's Data Release 2(DR2) were extracted for this project. The Multi-Layer Perceptron Classifier (MLP), was trained to recognize the CMD pattern of known dSphs for classification, using data from the Northern Hemisphere. Model accuracy was tested on the remaining Northern Hemisphere data. The MLP classifier achieved >90% accuracy in classifying known dSphs and non-dSphs. From the remaining Southern Hemisphere data from Gaia DR2, the classifier returned 24 potential candidates for dSphs. Examination of the candidates' clusterings in space, proper motion, and CMD verified the validity of these candidates. 3 clusters in the Northern Hemisphere testing set, shown as "misclassified" as dSphs because they were initially labeled unknown objects, were also potential candidates. An accurate model for detecting new dSphs has been developed using machine learning techniques. 27 potential dSph candidates have been identified. Further studies will examine the astrophysical properties of the candidates to determine whether any new dSphs have been discovered.