Projections for Rubin Observatory Legacy Survey of Space and Time (LSST) Telescope's Detection of New Milky Way Satellite Dwarf Galaxies

Rebecca Robinson Rey | University of North Florida | VFP Student Intern | Collaborators: Dan Hooper, Chris Kelso

Overview

In this project we will predict the amount of satellite dwarf galaxies in our Milky Way that the Rubin Observatory Legacy Survey of Space and Time (LSST) telescope might detect for indirect dark matter detection. This will be achieved by modeling the telescope's survey using a Monte Carlo. To perform an accurate modeling, we will first simulate the discoveries made by the Sloan Digital Sky Survey (SDSS), Dark Energy Survey (DES) and Pan-STARRS1 (PS1).

Dwarf Galaxies, gamma rays, and dark matter

The annihilation of weakly interacting particles (WIMPs) produces energetic particles including gamma rays. Dwarf galaxies are a great target for indirect dark matter detection since they have high concentrations of dark matter and low astrophysical background.

Dark Energy Survey (DES) and Pan STARRS1 (PS1)

The DES is an international collaborative project to map millions of galaxies. It started operation in 2013 and ran for six years.

PS1 is a telescope leading the world in Near Earth Object discovery. It's located on the island of Maui and started operations in 2014.

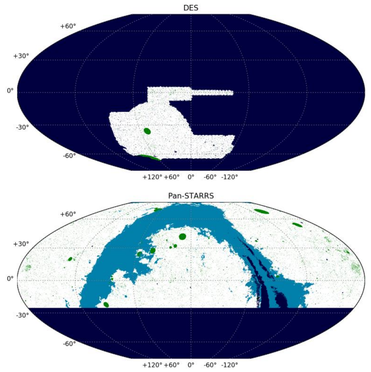

Figure 1. The top map shows the sky survey area for DES. The bottom map shows the sky survey for PS1. [1]

The Sloan Digital Sky Survey (SDSS)

The SDSS started operating in 2000 and has been in operation ever since. The SDSS survey only maps a small area on the north hemisphere of the sky (Figure 1).

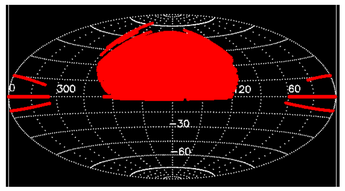

Figure 2. Sloan Digital Sky Survey (SDSS) sky survey area. source

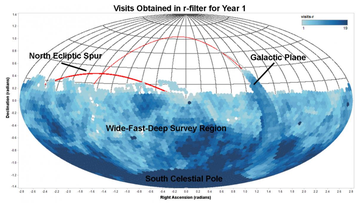

Figure 3. Legacy Survey of Space and Time (LSST) sky survey area. source

Rubin Observatory Legacy Survey of Space and Time (LSST)

The LSST telescope is set to run for at least 10 years, during which time it will collect astronomical data for the study of the deep universe. Its survey covers a large portion of the southern hemisphere of the sky (Figure 3).

Results

Using a Monte Carlo, we were able to get a distribution which could represent the results obtained from SDSS survey. Halos 14 and 20 were used in the simulation because of their resemblance to the Milky Way. The simulated data from Halo 14 has a more even distribution than the simulated data from random halos (Figure 4). The average number of simulated satellites from Halo 20 is closer to the number of satellites detected by SDSS (Figure 5).

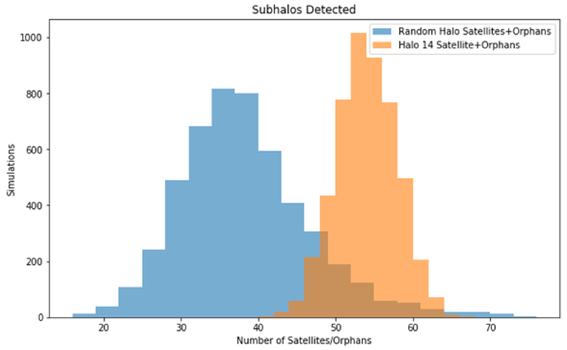

Figure 4. This histogram contains the number satellites detected from Halo 14 (orange) and the number of satellites detected from random halos (blue) in a simulation run 5,000 times. The average number of satellites detected from Halo 14 is 53.5 and the average number of satellites detected from the random Halos is 37.8.

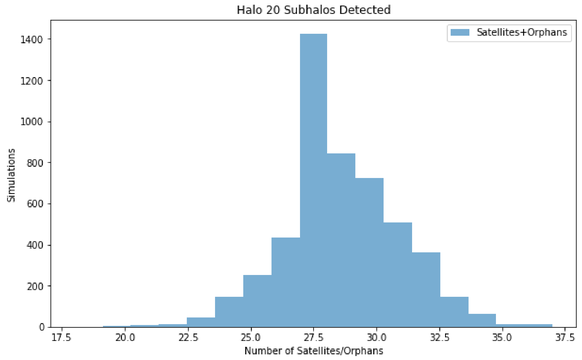

Figure 5. This histograms shows the number of satellites detected from Halo 20 in a simulation that ran 5,000 times. The average number detected is 28.6, which is closer to the total satellites detected by SDSS: 27.

Future Steps

The same process will be repeated for both DES and PS1. The dwarf galaxies simulated will then be used to see their impact on dark matter detection and their constraints.

References

[1] Drlica-Wagner, A., Bechtol, K., & Maul, S., et al. (2020, April). Milky Way Satellite Census. I. The Observational Selection Function for Milky Way Satellites in DES Y3 and Pan-STARRS DR1 (1912.03302).

Acknowledgements

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics..

FERMILAB-POSTER-22-168-STUDENT