Astrophysical Sciences & Technology
Ph.D. Dissertation Defense

Andrew Lipnicky

Galactic Building Blocks: Searching For Dwarf Galaxies Near and Far

Advisor: Sukanya Chakrabarti

Wednesday June 21st, 2017 3:00pm
Location: Carlson Auditorium 76 – 1125

Abstract:

The prevailing paradigm of structure formation that describes how matter is distributed throughout the Universe is known as the Λ cold dark matter paradigm. A key component of this paradigm is dark matter, which has so far gone undetected in laboratory experiments but is inferred from a wide variety of astrophysical observations. Although the cold dark matter paradigm is extremely successful on large scales, there are significant differences between what computer simulations predict and what we observe on galaxy scales. The purpose of the work presented in this Dissertation is to address some of the issues surrounding the current structure formation paradigm and further develop some tools for investigating small scale structure. An issue that has caused recent controversy is known as the Planes of Dwarf Galaxies problem which describes the curious alignment of the Milky Way's dwarf galaxies into a thin planar structure. We have investigated this structure though time by integrating their orbits using the latest proper motion data as well as compared the distribution with current cosmological simulations and found no significant difference between the Milky Way distribution and simulations.

Through analysis of observations of the disturbances in the extended neutral hydrogen disks of spiral galaxies, one can characterize dark matter substructure and the dark matter halo of a host galaxy. This process is called Tidal Analysis. Using a simple test particle code to model satellite interactions with a gas disk, we have developed a scaling relation to relate the observed density response of the disk to the mass and pericenter of a satellite. Changing gears to observational studies of small scale structure, we report observations of possible Cepheid variables in a putative dwarf galaxy located along the line of sight of the galactic plane that was first predicted through the use of Tidal Analysis. Finally, in an effort to use Tidal Analysis on other galaxies to constrain substructure, we have begun a 21-cm radio observing campaign of a set of spiral galaxies at redshift $z\sim0.1$ to obtain their total mass in neutral hydrogen. This unique set of galaxies also act as strong gravitational lenses, thus allowing us to use both Tidal Analysis and gravitational lensing together for the first time. We report a secure detection and mass measurement for one of our sources and six upper mass limits.