

Examples of Term Project Topics

In lieu of a final exam, Astro 233 students will present a report on their term projects. These examples of topics are just meant as suggestions to get you started thinking about a term project. Projects will all start with reading some relevant papers, but might include – or lead to – some original research. A few cosmology term projects in previous years have led to published papers. Please plan to decide on a term project in the next week or two. I'll try to help you choose a topic and find suitable articles to get you started.

Examples of topics to summarize from the literature:

- Clues to the nature of dark matter from small scale issues: cusps, satellites, ...
- Dwarf galaxies, and the galaxy luminosity function
- Tidal streams and implications, including shapes of dark matter halos
- Feedback effects in galaxy formation
- Outflows from galaxies
- Black holes in galactic centers – origins, correlations, and effects

Big bang nucleosynthesis and implications of possible ${}^7\text{Li}$ and ${}^6\text{Li}$ discrepancies

How to test Eternal Inflation theory, multiverses, or string/brane cosmology

Primordial black hole formation in the early universe and observational implications

CMB polarization measurements and implications for the nature of Cosmic Inflation

Searches for very high redshift galaxies; understanding cosmic reionization

- What is the high-redshift star formation rate density (Madau plot)?
- What is the escape fraction of ionizing radiation from high- z galaxies?

Structure of ΛCDM Dark Matter Halos (might involve analyzing simulations)

- Smallest scale CDM fluctuations and “boost” factor in WIMP annihilation
- Centers of dark halos – implications of observations for dark matter
- Phase-space properties of substructure
- Halo shapes – triaxiality, velocity anisotropy, radial dependence, implications
- Angular momentum distribution
- Effect of clump dynamical friction on dark matter distribution near cluster centers
- Power sources for cluster heating – e.g., supernovae, AGN, DM annihilation?
- Formation of the Local Group in the standard ΛCDM cosmology

Alternatives to the Standard ΛCDM $\Omega_m=0.3$ Cosmology, for example

- Warm Dark Matter, Interacting Dark Matter, Decay-product Dark Matter
- Modified Newtonian Dynamics (MOND) and other alternatives to GR

Constraints on Cosmology from Gravitational Lensing

Weak Lensing

Strong Lensing

Detection of WIMP Dark Matter

Cryogenic Detectors (e.g. CDMS, EDELWEISS, CRESST, ZEPLIN)

Directional Detectors, Dependence on Halo Shape and \mathbf{v} -Distribution

Are Dark Matter Caustics Important? (Sikivie vs. Moore)

Indirect Detection, e.g. of dark matter annihilation in galaxy centers

using Atmospheric Cherenkov Telescopes, GLAST, AMANDA/IceCube

Using DarkSUSY www.physto.se/~edsjo/darksusy or MicrOMEGAS

lappweb.in2p3.fr/lapth/micromegas/ WIMP particle astrophysics software

Semi-Analytic Modeling of galaxy formation – e.g.

Formation and evolution of low-mass galaxies, origin of scaling relations

Understanding the growing data on damped Lyman alpha systems

Formation and evolution of massive galaxies

Extremely Red Objects

Understanding the origin of galaxy color bimodality

Hydrodynamic simulations of galaxy formation and evolution

Formation of galaxies

The first stars

“Dark Stars” and possible effects of dark matter annihilation on the first stars

The first quasars

Galaxy merger simulations

Evolution of galaxy populations

Correlations of galaxies and of galaxy properties

Applying new galaxy morphology statistics

Nonparametric galaxy morphology statistics – e.g., G/M20, shapelets

Applied to galaxy merger simulations

Applied to various observational data sets

Correlations with other galaxy properties

Extragalactic Background Light and implications, including Spitzer and Herschel data

EBL lower limits by integrating the luminosity function

EBL upper limits from gamma rays

To what extent is the 850 micron EBL accounted for by known sources?

How much room is there for grey dust (revisit Aguirre & Haiman 2000)

How to determine the nature of dark energy

Figures of merit for dark energy experiments

Current and proposed experiments, including the Dark Energy Survey and the

WFIRST and Euclid missions