

Examples of Term Projects

These examples are just meant as suggestions to get you started thinking about a term project, to be presented as an oral report during the Final Exam week. Projects will all start with reading some relevant papers, but might include – or lead to – some original research. A few term projects in previous years have led to published papers. Please do some further thinking about your project, and plan to meet with me soon to discuss it further. 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

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

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

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

Redshift Surveys and Implications –

- Broad Redshift Surveys: 2dF and SDSS
- Deep Redshift Surveys, especially DEEP

Structure of Λ CDM 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 Λ CDM cosmology

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; models including ISO and Spitzer 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 Joint Dark Energy Mission