Examples of Term Projects

These 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 number of 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:
- Small scale problems with cold dark matter
- Angular momentum problems in galaxy formation
- Feedback effects in galaxy formation
- Outflows from galaxies
- Black holes in galactic centers – origins, correlations, and effects
- Dwarf galaxies, and the galaxy luminosity function
- Tidal streams

Is there any way to test Eternal Inflation theory, multiverses, or string/brane cosmology?

Black Hole formation in the early universe and observational implications

CMB Polarization Measurements and Implications

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

Alternatives to the Standard ΛCDM \( \Omega_m=0.3 \) Cosmology
- Warm Dark Matter, Interacting Dark Matter, Decay-product Dark Matter
- Modified Newtonian Dynamics (MOND) and other alternatives to GR

Structure of ΛCDM Dark Matter Halos (might involve analyzing simulations)
- Small scale CDM fluctuations
- Centers of dark halos
- 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
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 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 density software

Hydrodynamic simulations of galaxy formation and evolution
   Formation of galaxies
   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

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

Extragalactic Background Light and implications; models including ISO and Spitzer data
   EBL lower limits by integrating the luminosity function
   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)