AST 3800/8050: Structure Formation in the Universe Spring 2017

TR 1:10-2:25pm
Stevenson 6322
January 10 – April 20

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Course website: http://astro.phy.vanderbilt.edu/~berlinaa/teaching/8050_sp17/

Textbooks

There is no required textbook for this class. Readings will be assigned from review articles and lecture notes that will be posted on the class website. However a few good textbooks that can be used for reference are:

"Galaxy Formation and Evolution" by Mo, van den Bosch, & White (Cambridge)
"Structure Formation in the Universe" by Padmanabhan (Cambridge)
"Introduction to Cosmology" by Ryden (Addison Wesley)
"Modern Cosmology" by Dodelson (Academic Press)
"Cosmological Physics" by Peacock (Cambridge)

Topics Covered

Observations of galaxies: morphology, stellar populations
Galaxy distance indicators: Tully-Fisher, Faber-Jackson, Supernovae, etc.
Galaxy redshift surveys: selection effects, redshift-space distortions
Galaxy environments: groups, clusters, voids
Galaxy clustering: correlation functions, power spectra
Cosmological parameters
The Friedmann model
Dark Matter and Dark Energy
Cosmological distance measures
The growth of structure: linear perturbation theory
The growth of structure: spherical collapse model
Nonlinear evolution and N-body simulations
Dark matter halos: definitions, abundance, clustering, internal structure, history
Galaxy formation
The halo model of galaxy clustering
Observational cosmological probes

Course Requirements

Reading

There will be weekly reading from journal review articles and other sources. The assigned readings will be posted on the website.

Problem Sets
There will be occasional (roughly bi-weekly) problem sets. These will contain some pencil and paper problems, but will mostly be mini research problems that require using a computer. I will assume that you can program in your favorite language and that you are or can become familiar with a basic plotting package. This course is not meant to be competitive; you are welcome to collaborate with other students on any problems, as long as the final presentation is your own.

Current Literature Reports – *graduate students only*
One of the goals of this course is to help you to read, understand, and evaluate current literature in extragalactic astronomy. New astronomy journal preprints appear daily on the web at http://arXiv.org/list/astro-ph.CO/recent. Each week, pick one new paper (should have appeared on the preprint server within the previous two weeks) that is broadly relevant to the topics discussed in this course. Read it and write 1-2 paragraphs that summarize the paper. The style can be informal, as if you are mentioning the paper to a colleague and pointing out something interesting about it. Extra points for pointing out any potential weaknesses that the paper has. Reports are due via email every Monday at 5pm.

Final Presentation/Project
There will be a final presentation in place of an exam. I will split the class in teams of one or two students each and will assign each team a specific cosmological probe from the following list:

- Cosmic Microwave Background
- Baryon Acoustic Oscillations
- Galaxy Clusters
- Supernovae
- Weak Lensing

Each team will study their assigned cosmological probe by reading a couple review articles, and will give an oral presentation during a class near the end of the semester. The presentation should include the following elements: physics of the probe; brief history of its use; best current cosmological constraints from the probe; future experiments and prospects. Each team will also write up a short 2-page report summarizing their presentation.

Undergraduate students will have the option of doing a computational final project in place of the presentation.

Attendance
Attendance is required for this course because the material is not covered in a textbook and so you cannot just miss a class and learn the material on your own. You can miss up to two classes for any reason without penalty. After that, missed classes will affect your course grade.

Grading

Graduate students: Grading will be 20% based on the literature reports, 40% based on the problem sets, and 40% on the final presentation (assuming the attendance requirement is met). The lowest literature report will be dropped. There will be no exams.
Undergraduate students: Grading will be 60% based on the problem sets and 40% based on the final presentation.