Galactic and Extragalactic Astronomy

M W 1:00-2:15 PM

Course Description

This course will be an introduction to Galactic and Extragalactic Astronomy taught at the graduate level. The course spans 15 weeks of classes, some of which are shortened due to holidays. The first two thirds of the class, approximately 10 weeks, will cover many of the classical topics contained within Galactic and Extragalactic Astronomy. These will include galaxy classification and morphology, the properties of stars, stellar evolution, stellar kinematics, distance scales, and the interstellar media of galaxies. The primary text for this portion of the course will be the classic text *Galactic Astronomy* by Binney and Merrifield. While our detailed understanding of galaxies has advanced considerably since the publication of this text in 1998, it remains an authoritative resource for the fundamental principles. Additional material will follow from *Galactic Dynamics* by Binney and Tremaine. *Galactic Dynamics* is equally authoritative and is designed to complement *Galactic Astronomy*.

The final third of the class will focus on the theory of structure formation and phenomenological tools that are often used to interpret the observed properties of and spatial relationships between galaxies. This will serve primarily as an introduction to cosmic structure growth and statistics of galaxy clustering. Lecture notes will be the primary resource for this part of the course but much of the material is covered in *The Large-Scale Structure of the Universe* by Peebles, albeit succinctly. Though this syllabus is a rough plan for the course, I will likely adaptively refine the syllabus and the pace of the course based on feedback throughout the semester. I strongly encourage students to purchase the *Galactic Astronomy* as it will be the course's primary text and it contains many useful pieces of information in tabular form or in figures. This book will prove useful in solving the problem sets. The advanced material on structure formation will be covered in a self-contained matter. Nevertheless, I recommend obtaining *The Large-Scale Structure of the Universe* as it is a valuable reference.

The bulk of the grade in this course will be determined by performance on approximately bi-weekly homework assignments. Many problems will be relatively standard textbook problems. I will not necessarily cover all of the factual information or techniques necessary to solve the problem sets in class. The reasoning behind this is that the problem sets are designed to mimic what one may encounter during research. You may use any resource to obtain the necessary information and to learn the techniques, but please refer to the resource you've used. Some problems will require computational methods. Early in the course, these problems will be relatively simple and will build in complexity as the course progresses. The reasoning behind this is that almost all astronomical research requires at least some minimal familiarity with basic computational techniques. Any computational method and available software may be used so long as you describe the techniques you have employed. The goal of these problems will be to teach students to solve problems using computers and to learn some basic techniques that students may find useful throughout their careers. I encourage students to write programs in `FORTRAN` or `C` directly rather than using available commercial software packages. For many problems, this may be more time consuming at the outset but this will likely be beneficial and may save time in the long run. Nevertheless, this is not required. Students are encouraged to use the techniques and routines given in the *Numerical Recipes* books by Press et al. The full texts for these books are available free of charge at `http:www.nrbook.com`. For C programmers, the Gnu Scientific Libraries are very valuable (`http://www.gnu.org/software/gsl/`). A valuable resource for Fortran programmers is the CERN Library (`http://wwwasd.web.cern.ch/wwwasd/index.html`), in particular the CERN Library function minimization routine `minuit` is very robust and very widely used.

Course Topics Week by Week

Below I give a rough outline for the course. In almost all cases, I give a reference on the material. In most cases, I will only cover a fraction of the material from the references due to time constraints and problems will be based on material covered during class.

- Week 1: Introduction & Overview: *Galactic Astronomy* Chapters 1 & 2
- Week 2: The Properties of Stars: *Galactic Astronomy* Chapter 3
- Weeks 3 & 4: Galaxy Morphologies & Scaling Relations: *Galactic Astronomy* Chapter 4 and *Galactic Dynamics* Chapter 6
- Week 5: Gravitational Dynamics: *Galactic Dynamics* Chapter 2
- Week 6: Collisionless Systems: *Galactic Dynamics* Chapters 4 & 7
- Week 7: Stellar Populations: *Galactic Astronomy* Chapter 5
- Week 8: An Introduction to Cosmology & the Cosmic Distance Scale: *Galactic Astronomy* Chapter 7
- Week 9: Galactic Interstellar Media: *Galactic Astronomy* Chapters 8 & 9

- Week 10: Galactic Evolution & Environments
- Week 11: An Introduction to Spatial Clustering Statistics: *The Large-Scale Structure of the Universe* Chapters 29-38
- Week 12: Dark Matter in Galaxies
- Week 13: The Growth of Cosmological Structure: *The Large-Scale Structure of the Universe* Chapters 6-16
- Week 14: Nonlinear Cosmological Structure Growth
- Week 15: Dark Matter Halos and the Halo Model of Clustering

Useful References

- *Galactic Astronomy* by Binney & Merrifield, Princeton University Press, 1998
- *Galactic Dynamics* by Binney & Tremaine, Princeton University Press, 1987
- *Galaxies in the Universe*, by Sparke & Gallagher, Cambridge University Press, 2000
- *The Large-Scale Structure of the Universe* by Peebles, Princeton University Press, 1980
- *Astrophysics of Gaseous Nebulae and Active Galactic Nuclei* by Osterbrock, 1989