Course Description

General: overview, classification, groups, black holes, stars; Milky Way: basic data, distribution of stars, gas, dust and relativistic particles, large-scale structure and rotation, dynamical components; Disk galaxies: stellar dynamics and stability, density waves, bars; Elliptical galaxies: stellar dynamics, mass profiles; Galactic nuclei: dormant black holes, AGN, starburst galaxies, issues of feedback; Galaxy formation and evolution: chemistry, cannibalism, interactions, environment.

Goals of this Course

A. Main aim is to get to the point where you can appreciate why current papers in the literature are being written.

B. Review the physical properties of the Milky Way and external galaxies.

C. Introduce some theoretical tools to help you understand kinematics and dynamics of galactic systems.

Course Outline

I. Introduction and Review (2 lectures)
   • General outlook on galaxies
   • Morphological classification
   • Galaxy groups and clusters
   • Supermassive black holes
   • Review: stars and stellar evolution

II. Our Galaxy (5 lectures)
   • Stars: counts, luminosity and density functions, stellar populations
   • ISM: phases, distribution, theory
   • Kinematics: Solar motion, LSR, Oort constants, rotation curve
   • Dynamics: potential theory, decomposition of Galactic components
III. Disk Galaxies *(4 lectures)*
- Observational summary
- Stellar orbits in disk potentials
- Stability of disks
- Spiral structure & density wave theory
- Weak and strong bars

IV. Elliptical Galaxies *(4 lectures)*
- Observational summary
- Stellar relaxation
- Stellar hydrodynamics
- Velocity ellipsoids, triaxiality
- Mass profiles

V. Galactic Nuclei *(4 lectures)*
- Evidence for a supermassive black hole in our Galaxy
- Dormant supermassive black holes in nearby galaxies
- Active galactic nuclei
- Starburst galaxies
- Feedback processes

VI. Dark Matter *(2 lectures)*
- Mass determinations and mass-to-light ratios on various scales
- Composition of dark matter

VII. Extragalactic Distance Scale *(1 lecture)*
- Tully-Fisher relation for spiral galaxies
- Fundamental plane of elliptical galaxies
- Surface brightness fluctuations
- Others: Globular clusters, planetary nebulae, and supernovae

VIII. Galaxy Evolution and Formation *(5 lectures)*
- Chemical evolution
- Dynamical friction, cannibalism, and ram pressure stripping
- Tidal interaction and merger
- Galaxy luminosity function and its dependence on the environment
- Models of galaxy formation
Required books:

Problem sets: 4 sets during the semester. A mixture of types: practical (web search); dull & routine (stuff skipped in class); challenging thought problems. You can talk to any students about a problem but the write-up should be your own.

Short Talk: Five-minute talk in AAS style. Short talks will be scheduled sometime at the end of October, so let me know your topic within a couple of weeks. To get a manageably small topic for a short talk: pick a general area that interests you and find a recent paper within that area of special significance (advice: avoid papers on which I am a co-author!). Then “pretend” that you are the author of the paper presenting the results at a AAS meeting. In such a situation, you’d be trying to get the idea of your work over as quickly and clearly as possible, as well as making your audience appreciate how it fits into the “big picture”. The recommended rule-of-thumb is to try to have less than one slide/minute, so do the math!

Term paper: Write *in your own words* – very important – a paper of 10-15 pages: maximum of 10 single-spaced pages of text + references + figures. On extragalactic topic of your choice. The term paper is meant to be a short literature review. For possible material, take a look at the most recent (< 5 years) issues of the “Annual Review of Astronomy and Astrophysics.” This paper is due on the last day of classes. See possible topics below.

Mid-term and Final Exams: closed book, in-class. The final exam is on Monday, December 19 at 1:30 - 3:30 pm. The mid-term is tentatively scheduled for Monday, October 17 at 2:00 - 3:15 pm.

Grading:

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<th>Component</th>
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<tr>
<td>Homeworks</td>
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<td>Short talk</td>
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<td>Term paper</td>
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<td>Mid-term exam</td>
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<td>Final exam</td>
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Possible Topics for Term Papers:

The following list is not meant to be exhaustive. It is simply a list of interesting subjects we won’t be able to cover adequately in class. Feel free to select your own idea rather than one of these.

- dwarf galaxies: companions to the Milky Way
- Secular evolution: pseudobulge, bulge - stellar bar connection
- probing the Galactic halo from gravitational microlensing
- the RAVE survey – globular clusters: formation & dynamics
- low surface brightness galaxies
- ultrathin disk galaxies
- Lyman break galaxies
- quasar hosts
- galaxy formation and evolution: mergers vs cold stream accretion
- X-ray properties of galaxy clusters
- galaxy cluster mass determinations from gravitational macrolensing
- the Sunyaev-Zel’dovich effect and its applications
- dynamics of the Local Supercluster
- Ly-alpha absorption line clouds
- the Hubble Deep Fields: description and results
- the COSMOS survey: description and results
- distant Ly-alpha emitting galaxies
- the extragalactic X-ray background
- the extragalactic far-infrared background
- the global star formation history of the universe
- the extragalactic legacy of the Spitzer Space Telescope
- recent extragalactic results from the Herschel Space Observatory