

**Astronomy 31300: Selected Topics in Extragalactic Astronomy
Spring Quarter, 2007**

Class: Wed., Fri. 10:30 – 11:50 am

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I. Galaxies Observed:

- Challenges/Limitations to Extragalactic Astronomy:
 - Atmospheric absorption and emission:
 - Surface brightness and sky subtraction errors
 - Photometric calibration: filter, detector response/efficiencies
 - Milky Way dust absorption and emission
 - Observing in the Expanding Universe: K corrections, surface brightness dimming
 - Galaxy photometry: aperture vs model fit photometry
- Overview of the Milky Way (probably skip):
 - Stellar populations; bulge; thin & thick disks; globular clusters
 - Gas in different phases
 - Dust, metals
 - Ionizing radiation
 - Dark Matter
- Galaxy Types and Classification:
 - Morphological, color, and spectroscopic classification schemes
 - The Hubble sequence
 - Surface brightness profiles: de Vaucouleurs spheroids and exponential disks
 - Automatic morphology classification: neural networks
 - Morphological classification in SDSS
 - Classification caveats
 - Bimodal galaxy color distribution
 - Interpretation of galaxy spectra: stellar and ISM signatures; velocity dispersion;
 - Spectroscopic classification via Principal Component Analysis
 - Correlations between spectroscopic and photometric properties
 - Morphology-density relation
 - Oddballs: irregulars, starbursts, ULIRGs, CDs

- Galaxy Population Distributions:
 - Galaxy Luminosity Function: Estimation, Results, Schechter fits
 - Luminosity Function by Galaxy Type
 - Malmquist bias, K corrections
 - Luminosity functions for photo-z samples
 - Velocity Dispersion Distribution Function for early-type galaxies
- Galactic Structure & its regularities:
 - Scaling relations: Tully-Fisher, Faber-Jackson, Fundamental Plane

II. Galaxy Dynamics and Dark Matter

- Dynamical evidence for dark halos:
 - stellar and gas rotation curves in disk galaxies
 - elliptical galaxy velocity dispersions
 - satellite dynamics
 - Mass models (e.g., SIS) and M/L ratios; halo shapes
 - dwarf galaxies: the cusp problem for CDM halos
- Gravitational lensing by galaxies:
 - Microlensing constraints on compact dark matter
 - Strong lensing constraints
 - Galaxy-galaxy weak lensing: halo extent, correlations, etc
 - Galaxy Photometry II: 2nd moments, shapelets, correcting for seeing and PSF anisotropy
- Black Holes in Galaxies:
 - Dynamical evidence for black holes in galaxy cores
 - Black hole-bulge scaling relations
- Spiral Structure (probably skip):
 - Density wave theory

III. Galaxy Evolution and Formation:

- Galaxy luminosity evolution:
 - Cosmic Star Formation History: Madau plot
 - Luminosity evolution from population synthesis models
 - Galactic chemical evolution; metal enrichment by winds and SNe
 - High-redshift galaxies: Lyman-break galaxies, starbursts, submm sources, EROs

- Galaxy Dynamical Evolution and Formation Issues:
 - Wet and dry mergers: tidal stripping, heating and cooling timescales; origin of Hubble sequence? Merger-induced star formation
 - Semi-analytic models
- QSO Absorption Line Systems: the IGM at high redshift:
 - Metal line systems, Ly-alpha forest, damped systems, limit systems
 - The Lyman-alpha forest and the cosmic web
 - Gunn-Peterson test and reionization
 - Where are the baryons today?
- 21 cm Surveys and Early Galaxies

IV. Active Galaxies:

- AGN:
 - General properties: variability, broad spectrum, luminous,...
 - AGN zoo: Seyferts, radio galaxies, LINERs, OVV, blazars, BL Lac, etc
 - Black Hole accretion as the engine: Eddington limit; superluminal motion
 - Unified model of AGN
 - Population properties of active galaxies
- AGN at high redshift:
 - QSOs, quasars, etc.
 - QSO luminosity function and its evolution

V. Groups and Clusters

- Galaxy Groups:
 - Local group
 - New dwarfs in the LG: Sagittarius, Andromeda satellites
 - Satellite problem in CDM
 - SDSS group catalogs
- Clusters I: Optical
 - optical cluster identification; the red sequence; maxBCG; richness measures
 - Spectroscopic velocity dispersions and virial mass estimates
 - galaxies in clusters: tidal stripping, etc
 - Scaling relations, cluster M/L

- Clusters II: X-ray
 - Intracluster medium: hot gas; luminosity and temperature measurements
 - Models: hydrostatic equilibrium; beta model and descendants
 - metal enrichment; feedback from SNe and AGN; preheating
 - Scaling relations
 - cooling flows and cooling flow problem
- Clusters III. Sunyaev-Zel'dovich
 - CMB and the SZ effect; measurements
 - scaling relations
- Clusters IV. Gravitational Lensing
 - Strong lensing in clusters: arcs
 - Weak lensing in clusters: mass reconstruction
 - Statistical weak lensing: cluster-mass correlation function
 - The bullet cluster
- Clusters V. Population properties
 - Cluster mass function: Press-Schechter theory and extensions
 - Clusters as Cosmological Probes (σ_8 , dark energy)

Additional Topics (depending on time and interests):

- Large-scale structure:
 - galaxy surveys
 - galaxy clustering measures
 - models of LSS formation
- Cosmological Distance Measurements
- Cosmic Background Radiation

Required Work

There will be ~ 3 homework sets. There may be a final exam or project.

References

Binney & Merrifield, Galactic Astronomy

Binney & Tremaine, Galactic Dynamics

Krolik, Active Galactic Nuclei

Annual Review and journal articles and preprints

Class Schedule

There will be no class on Friday, March 30 or Wednesday, April 4. We will schedule two make-up classes. My initial proposal is Monday, April 16 and Monday May 14.