Astronomy 830: Observed Properties of Stars & Galaxies

Winter Quarter 2004

Time/Place:

9:00-10:18 MWF, 1186 Smith Lab (first floor, SE corner)

Course Topics:

I. Properties of Stars (4 weeks)

Distances and Motions

- Trigonometric Parallaxes
- Proper Motions, Radial Velocities & True Space Motions
- Secular & Statistical Parallaxes
- Astrometric Catalogs & Future Space Missions

Masses & Radii

- Visual, Spectroscopic & Eclipsing Binaries
- Stellar Radii: Lunar Occultations & Interferometry

Spectral Classification

- Historical Overview & the modern MKK System
- L & T dwarfs
- Luminosity Classes
- Special Classes of Stars

Stellar Properties:

- Effective Temperature
- Surface Gravity
- Metallicity
- Luminosity & Bolometric Magnitudes

Relations among Stellar Properties

- Hertzsprung-Russell & Color-Magnitude Diagrams
- Main Sequence Mass-Luminosity Relation
- Main Sequence Mass-Radius relation

Stellar Photometry & Spectrophotometry

- Photometric Systems (brief overview)
- Physical properties derived from photometry
- Color-Color Plots at Visible & IR wavelengths
- Line Blanketing & UV Excess

Interstellar Extinction

- Total & Selective Extinction, R_V
- Ways of estimating A_V and R_V.
- Interstellar Extinction Curve – properties & features, correlation with N_H
- Reddening vectors

Pulsating Stars
- Fundamental & 1st overtone pulsations (the κ mechanism)
- The Instability Strip
- Types of pulsating variables (Cepheids, W Vir, RR Lyr, Mira)
- Period-Luminosity Relations
- Baade-Wesselink Distance Method

The Stellar Luminosity Function
- Star Counts
- The Malmquist Bias
- Results for the Solar Neighborhood

II. The Milky Way (2 weeks)

Components of the Milky Way
- Open & Globular Star Clusters (properties, locations, CMDs, etc.)
- Disk, Halo, & Bulge
- The Galactic Center

Kinematics & Dynamics
- Local stellar kinematics (apex, LSR, etc.)
- Oort Constants
- Rotation Curve
- Warps

Stellar Populations & Chemical Abundances
- Pop I and II and their discontents
- Chemical Abundances (ISM & Stars)
- Chemical Evolution (simple closed box and infall models)

The Local Group

III. Properties of Normal Galaxies (4 weeks)

Morphological classification of galaxies
- Hubble Tuning Fork (historical & practical overview)
- Later modifications (DDO & DeVaucouleurs)
- Distribution of Morphological Types

Galaxy luminosity function
- Schechter Function
- Basic Issues: passbands, brightness estimates, extinction & K-corrections
- Recent results (esp. SDSS field-galaxy studies)
- Quantities derived from the luminosity function

Surface Photometry of Galaxies
- Basic principles and practical issues of measurement, conventions for denoting
- Isophotal Radii (Holmberg & DeVaucouleurs)

Photometry of Elliptical Galaxies
- Hubble & King Laws, DeVaucouleurs Law, Sersic & "Nuker" Profiles
- Shapes of Ellipticals (Azimuthal Moments, Isophotal Twisting, True Shapes)
- Faber-Jackson & Color-Magnitude Relations
- The Fundamental Plane & D_n-σ relations

Disk Galaxies
- Radial Surface Brightness Profiles (exponential disks + bulges)
- Vertical Structure
- Spiral Structure

Dust in a Galactic Context
- Local (Galactic) Absorption
- Internal Extinction & galaxy "transparency"
- Direct observation of dust (Far-IR emission)

ISM in Galaxies – A basic overview
- Components (HI, H_2, HII, hot ISM)
- Correlations among types
- Distribution within galaxies

Kinematics of Galaxies
- Rotation curves of disk galaxies
- Dynamical Masses of disk galaxies
- Velocity Dispersion & Rotation in Ellipticals
- Dynamical Masses of Ellipticals

Star Formation in Galaxies
- Star Formation Diagnostics (Integrated spectra, UV cont., emission lines, Far-IR)
- Circumnuclear & Global Starbursts
- Star Formation Regulation (Schmidt & Kennicutt Laws)
- Initial Mass Functions & their influence on SFR estimates

Textbook:

Binney & Merrifield, *Galactic Astronomy* (Princeton Univ. Press)

Evaluation:

60% homework, 40% final exam. Class participation in discussions and activities will be factored into the course grade.

Final Exam:

The final examination will be a 60-minute closed book, closed notes exam in the same style as the general exam (3 questions, equal weight).

Course Objectives:

This course is intended to provide incoming graduate students with an overview of the basic properties of stars and normal ("non-active") galaxies, the basic properties of the Milky Way galaxy, the methods used to measure these properties and their uncertainties, and to introduce and elaborate on the various conventions that are used for the measurement and expression these properties in common research practice. These topics form the empirical basis upon which modern astrophysics rests, and the essential starting point for graduate studies in astrophysics. Upon completion, students should be able to understand research papers and talks dealing with these topics.