

Astronomy 515: The Interstellar Medium

Spring 2009

Tu Th 11:00a - 1pm, SO 204

Instructors: Jill Bechtold, John Bieging**Home Page:** <http://boojum.as.arizona.edu/~jill/a515.html>**TEXTS:**A.G.G.M. Tielens: *The Physics and Chemistry of the Interstellar Medium*D. Osterbrock & G. Ferland: *Astrophysics of Gaseous Nebulae and Active Galactic Nuclei*

Other books will be on reserve in the Steward Library (Parker Room).
Supplementary Journal Articles and Reviews will be recommended.

GRADES:

50% Final Exam

50% Homework, Class Participation and Class Oral Presentation

COURSE OUTLINE:

1. Phases of the ISM (John)
 - atomic and molecular hydrogen clouds
 - stability criteria
 - cooling curves
 - heating sources
 - multi-phase models
2. Supernovae and shocks (John)
 - some basic hydrodynamics
 - jump conditions
 - Sedov-Taylor solution for SN evolution
 - SN contribution to ISM (energy and matter)
 - shocks in other ISM contexts
 - observational diagnostics of shocks
3. Dust (John)
 - fundamentals of extinction
 - composition and other properties of dust grains
 - sources and sinks of grains
 - connection with solar system materials
4. Star Formation (John)
 - models and mechanisms
 - accretion disks
 - bipolar outflows
 - observational signposts and diagnostics
5. Stellar Winds (John)
 - cool stars: molecules; planetary nebulae
 - hot stars: bubbles and shells in the ISM
 - return of matter and energy to ISM
6. Review of spectroscopy and radiative transfer (Jill)

- definitions
- equation of radiative transfer
- spectroscopic notation and selection rules
- atomic and molecular spectra

7. Absorption line studies (Jill)

- review of Voigt profiles, curve of growth, doublet ratios
- results from Copernicus, IUE, HST, FUSE for the Milky Way
- element depletion patterns

8. Ionization and thermal equilibrium of gaseous nebulae (Jill)

- description of physical processes
- thermodynamic equilibrium, timescales
- Milne relation, detailed balance, Saha equation
- spectral line formation:
 - T, n diagnostics, abundances
 - H and He recombination spectra
 - relative Balmer fluxes
 - forbidden lines, critical density
 - resonance fluorescence
 - near- and mid- IR spectral line diagnostics
- H II regions: structure, ionizing stars
- planetary nebulae

9. ISM in external galaxies (Jill)

- survey of observations: HI, CO, etc. for normal galaxies
- warm ionized medium
- environmental influences
- composition gradients in spiral galaxies
- starburst, infrared luminous galaxies
- chemical evolution
- hot phase processes (cooling flows, X-ray coronae)
- QSO absorption lines
- history of the intergalactic medium
- ISM in active galaxies
- Dust and molecular gas at high redshift; high-redshift starbursts and protogalaxies
- X-ray emitting intra-cluster medium

10. AGN and QSO spectra (Jill)

- basic optical/UV/NIR/X-ray spectral properties and physical picture
- resonant line scattering
- Fe II emission
- broad line region models
- reverberation mapping of the broad line region
- Quasar Winds: observations and models
- GPS and CSS radio galaxies and quasars
- X-ray Fe K-alpha emission and accretion disk models for AGN