AST 383C

Stellar Atmospheres

Fall 2016

TuTh 12:30 - 2:00 RLM 15.216B; Unique No. 47610

LEVEL:

Hubeny & Mihalas, The Theory of Stellar Atmospheres 2015

Böhm-Vitense, Introduction to Stellar Astrophysics: Volume 2

Gray, Observations and Analysis of Stellar Photospheres

Rybicki and Lightman, Radiative Processes in Astrophysics

SYLLABUS

I. Summary of Observational Data: Motivations for studying stars. Spectral and luminosity classification. Relation of theory and observation. An approach to Flat stars: *accretion disks*.

II. Elements of Radiative Transfer Theory: Definitions. Emission, absorption, and scattering. Equation of transfer, radiative equilibrium.

III. Gray Atmospheres: Milne's equation. Two-stream and Eddington approximations. Emergent flux and limb darkening.

IV. Local Thermodynamic equilibrium (LTE): Elements of statistical mechanics. Perfect gases and the Saha equation. Conditions for LTE. Depression of the adiabatic gradient in a partial ionization zone.

V. Non-LTE: Rate: Rate equations. Radiative and collisional rates; departure coefficients. Calculation of Einstein coefficients and collision cross-sections.

VI. Continuum Opacity: Opacity sources in high-, intermediate-, and low-temperature stellar atmospheres.

VII. LTE Continuum model Atmospheres: Basic equations. Numerical solution of transfer equation: Lambda-iteration; Kurucz's and Feautrier's methods. Temperature-correction procedures.

VIII. Results and Comparison With Observations: Absolute energy distributions. The Balmer jump. Sample model atmosphere calculation. Flux distributions for sample model stars. Effect of absorption edges on atmospheric structure, line-blanketing, molecule formation.

IX. Line Spectra: Line absorption profiles. Natural broadening and the Lorentz profile. Doppler broadening and the Voigt profile. Collisional broadening. Stark broadening, Inglis Teller formula.

X. Line Transfer Problem.: Line transfer equation: pure scattering lines and pure absorption lines. Center-to-limb variations. Schuster mechanisms. Curve of growth and abundance determinations. Model atmosphere line calculations. Line blanketing theory, LTE line formation.

XI. Experimental Astrophysics: Line broadening and continuum lowering. New empirically validated approaches.

XII. Convective Energy Transport: Partial ionization zones. Mixing Length Theory. Simple phenomenological models. But what about the kinetic energy of turbulence? Modern approaches through 3D simulations.

Course Structure

Subject Matter: We may broaden the scope of the syllabus slightly to consider more general radiative processes in astrophysics if time permits.

Office hours: 2pm Tu or by appointment. RLM 16.236 (office) or RLM 16.234 (lab).

Email and Telephone: I prefer questions by e-mail. You can e-mail me at dew@astro.as.utexas.edu. If you need to phone: (512) 471-3404 (office), (512) 826-6730 (cell).

Grading: Your grade will be based on three elements with the weights shown:

1. Problem sets and quizzes: 25%

2. Class notes, class participation & daily reviews: 25%

3. Class project: 50%

Comments: I expect that you will help each other with the problem sets, but only to the extent of locating references and discussing general approaches to each problem. Your solutions must be uniquely yours. The notes must consist of much more than just a copy of the equations written on the board or in the book. *Your notes will form the core of your understanding of stellar atmospheres and radiative processes for the rest of your career*. I will also attempt to share with you my ideas on how to think about scientific problems, choose research topics wisely, and develop a successful career in science. I expect active participation in class. Your grade in element 2, above, will reflect this.

Deadlines: There are no excuses for late assignments. There is no such thing as a late assignment in this class.

There are no make-up exams. All quizzes are in-class. The projects will be presented in-class during the final week of class. Because of the comprehensive nature of the projects, as well as the amount of work involved, there will be no final exam given during the scheduled final exam period. Your work in this class is finished, by definition, on the last class day; there are no incompletes.