AST 810, Fall 2017

Radiation Astrophysics

Syllabus

This graduate-level course covers the physics of radiation, the interaction of radiation with matter, and the application of radiative processes to astrophysical phenomena.

Goals

The primary purpose of a graduate-level course is to weave into a coherent whole the threads of physics and astronomy knowledge you already possess, and to teach you to think like an astrophysicist. Accordingly, by the conclusion of this course you should be able to

- solve simple radiative transfer problems at a blackboard;
- solve more complicated radiative transfer problems by finding, reading, and applying methods from the current scientific literature; and
- interpret spectra and make good inferences about the physical characteristics of their sources.

Knowledge of undergraduate-level electrodynamics, quantum mechanics, and thermodynamics is expected. Advanced topics in these areas will be brought into the class discussion as needed, so that the course will be self-contained.

Instructor

Prof. Edward Brown

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Office hours are informal: if my door is open, you are welcome to drop in. You may also make an appointment.

Class

Official class times are Tuesdays and Thursdays, 8:30 to 9:50, in 1415 BPS. *Tentatively*, however, we will meet in 1300 BPS from 8:45 to 10:05. The 15 minute shift is by request; if this causes any inconvenience, please let me know.

Text

The primary texts are Rybicki and Lightman (1979) and my course notes, which draw on the sources listed in the references. You are welcome to borrow these books (or any others) from me for a limited time. Any updates to the course notes will be posted on D2L as they are completed.

Components

Problem sets Expect weekly to biweekly homework, in-class worksheets, and reading assignments. As you know, most of your competency gain occurs while working problems and discussing them with peers. We'll spend a fair bit of class time discussing problem sets, so come ready to present your work—class participation is expected, and your contribution to the in-class discussion will be evaluated as part of your grade.

Term paper You will write a term paper on a topic related to radiative processes in astrophysics. You will decide on this topic in consultation with me. The writing must conform in style to that of *The Astrophysical Journal*; I shall provide a LaTeX template. The papers will be peer-reviewed: each of you will referee three of your classmates' papers, and your grade will take into account both the reviews of your paper and the reviews that you write.

Exams There will be 3–4 short written quizzes, announced in advance, and a written final.

Grades

The overall course grade is computed using the following weights.

Homework	35%
Participation	10%
Paper & review	25%
Quizzes	10%
Final	20%

Grading of problem sets will be on a three-point scale: − ("needs improvement"), ✔ ("satisfactory"), and ✚ ("outstanding"). All exams will be graded in detail.

No rule of scholarly activity is more important than giving proper credit for the contributions of others. Although you are free to consult with classmates while working on assignments, you must explicitly acknowledge them by name and indicate their contributions in the write-up. The work on the term paper and all exams must be entirely your own.

References and reading list

Gordon Baym. *Lectures on Quantum Mechanics*. Addison-Wesley, 1990.

V. B. Berestetskii, E. M. Lifshitz, and L. P. Pitaevskii. *Quantum Electrodynamics*, volume 4 of *Course of Theoretical Physics*. Pergamon, 2nd edition, 1980.

Hans A. Bethe and Edwin E. Salpeter. *Quantum Mechanics of One- and Two-Electron Atoms*. Dover, 2008.

Raymond T. Birge. On the establishment of fundamental and derived units, with special reference to electric units. Part I. *Am. J. Phys.*, 3:102, 1935a.

Raymond T. Birge. On the establishment of fundamental and derived units, with special reference to electric units. Part II. *Am. J. Phys.*, 3:171, 1935b.

S. Chandrasekhar. *Radiative Transfer*. Dover, 1960.

Richard P. Feynman, Robert B. Leighton, and Matthew Sands. *The Feynman Lectures on Physics*. Addison-Wesley, 1989.

W. Heitler. *The Quantum Theory of Radiation*. Dover, 1984.

Ivan Hubeny and Dimitri Mihalas. *Theory of Stellar Atmospheres: An Introduction to Astrophysical Non-equilibrium Quantitative Spectroscopic Analysis*. Princeton Series in Astrophysics. Princeton University Press, 2014.

John D. Jackson. *Classical Electrodynamics*. Wiley, 2d edition, 1975.

L. D. Landau and E. M. Lifshitz. *The Classical Theory of Fields*, volume 2 of *Course of Theoretical Physics*. Pergamon, 4th edition, 1975.

Malcolm S. Longair. *Particles, Photons, and Their Detection*, volume 1 of *High Energy Astrophysics*. Cambridge University Press, 2d edition, 1992.

D. Mihalas. *Stellar Atmospheres*. W. H. Freeman, 2d edition, 1978.

Donald E. Osterbrock. *Astrophysics of Gaseous Nebulae and Active Galactic Nuclei*. University Science Books, 1989.

P. Richter, K. R. Sembach, and J. C. Howk. H_2 absorption in a dense interstellar filament in the Milky Way halo. *A&A*, 405:1013–1023, July 2003. doi: 10.1051/0004-6361:20030722.

George B. Rybicki and Alan P. Lightman. *Radiative Processes in Astrophysics*. Wiley, 1979.

Frank H. Shu. *Radiation*, volume I of *The Physics of Astrophysics*. University Science Books, 1991.

Lyman Spitzer. *Physical Processes in the Interstellar Medium*. Wiley, 1978.

Kip S. Thorne and Roger D. Blandford. *Modern Classical Physics*. Princeton University Press, 2017.

H. C. van de Hulst. *Light Scattering by Small Particles*. Dover, 1981.

Steven Weinberg. *Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity*. Wiley, 1972.

Anthony Zee. *Quantum Field Theory in a Nutshell*. Princeton University Press, 2d edition, 2010.