PHYS 8900 Advanced Topics:
Atomic and Molecular Astrophysics of Gaseous Nebulae
Fall 2009

Instructor: Phillip Stancil
Times and Location: TuTh 11:00am-12:15pm, Physics 254
Credits: 3 hours
Office Hours: M 10:00-11:00am, Tu 4:30-5:30pm, Th 1:00-1:50pm;
other times by appointment only
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Prerequisite: None, but ASTR 8090 (The Interstellar Medium) would have been useful. The course will assume basic knowledge of upper level physics and astronomy undergraduate material.

Introduction

The goal of the course is to give an introduction to the physics and chemistry of photoionized and collisionally-ionized gas in astrophysics. The basic flow of the course will follow the general outline given in Osterbrock and Ferland (2006), but additional topics will be introduced as appropriate. In particular, emphasis will be placed on relevant atomic, molecular, solid-state, and nuclear processes and their role in thermal balance, ionization balance, chemistry, and photon spectra. Some fluid dynamics and radiative transport will be introduced. The course is intended to be an extension of ASTR 8090, but with a focus on higher-energy astrophysical environments and processes. A variety of applications, drawn from the current astrophysical literature, will be presented and discussed as time allows.

Required Textbook

- *Astrophysics of Gaseous Nebulae and Active Galactic Nuclei*, 2nd Edition, by D. E. Osterbrock and G. J. Ferland (University Science Books, 2006)

Additional Resources

- *Spectroscopic Challenges of Photoionized Plasmas*, edited by G. J. Ferland and D. W. Savin, American Society of the Pacific Conf. Ser., Vol. 247 (2001)
- *The Formation of Stars*, by S. W. Stahler and F. Palla (Wiley-VCH Verlag, 2004)
- *The Physics and Chemistry of the Interstellar Medium*, by A. G. G. M. Tielens (Cambridge University Press, 2005)

- *Molecular Astrophysics of Stars and Galaxies*, edited by T. W. Hartquist and D. A. Williams (Oxford Univ. Press, Oxford, 1998)
- Course website, ultimately to be found at: www.physast.uga.edu/classes/

Assignments and Grading Policy

I expect to give six or seven homework assignments throughout the semester involving typical analytical problem solving. Students are expected to read the textbook and are required to participate in class discussions. Attendence is mandatory, but the student will be allowed two excused absences. Grades will be determined from:

- 80% Average of homework assignments
- 20% In-class participation

The final letter grading scale determined from the composite of the course assignments will be: 100%-90% : A; 89.9%-85% : A-; 84.9%-77% : B+; 76.9%-70% : B; 69.9%-65% : B-; 64.5%-60% : C+; 59.9%-55% : C; 54.9%-50% : C-; 49.9%-45% : D; <45% : F.

Preliminary Course Outline

- Introduction to Gaseous Nebulae
- Ionization Balance, Atomic and Electron Collisions
- Thermal Balance in High Temperature Gas
- Line and Continuum Emission
- Temperature and Density Diagnostics
- Introduction to Gas Dynamics
- Dust and Its Various Roles
- Thermal Balance and Collisions in Low Temperature Gas
- Chemistry in Gaseous Nebulae
- X-ray Processes in Gaseous Nebulae
- Application: Planetary Nebulae
- Application: Photodissociation Regions
- Application: X-ray Dominated Regions
- Application: Supernova Remnants and Ejecta
- Application: The Early Universe and Primordial Stars
- Application: Active Galactic Nuclei