University of Toronto, Department of Astronomy

RADIATION PROCESSES

Course Outline for AST1440F

I. INTRODUCTION

1. Review of Basic Concepts

1.1 Overview of Radiation Processes
1.2 Electromagnetic Waves
1.3 Power Spectra
1.4 Radiative Transfer
1.5 Blackbody Radiation
1.6 Thermodynamic Equilibrium
1.7 Kirchoff's Law for Thermal Emission
1.8 Einstein Coefficients
1.9 Polarization and Stokes Parameters

II. CONTINUUM PROCESSES INVOLVING FREE ELECTRONS

2. Classical Radiation Theory

2.1 Single Particle Emission
2.2 Relativistic Treatment
2.3 Particle Ensembles
2.4 Thomson Scattering
2.5 Radiation From Oscillating Bound Charges

3. Thermal Bremsstrahlung

3.1 Classical Treatment and Quantum Corrections
3.2 Case Study: H II Regions at Radio Wavelengths

4. Synchrotron Radiation

4.1 Emission by a Single Particle in a Vacuum
4.2 Volume Emissivity of a Power-Law Distribution
4.3 Polarization of Synchrotron Radiation
4.4 Transition From Cyclotron to Synchrotron Emission
4.5 Synchrotron Self-Absorption
4.6 Case Study: Equipartition in Supernova Remnants

5. Compton and Inverse Compton Scattering

5.1 Compton Scattering
5.2 The Inverse Process
5.3 Maximum Brightness Temperature
5.4 Scattered Photon Field

6. Plasma Effects

6.1 Dispersion
6.2 Faraday Rotation
6.3 Cerenkov Radiation
6.4 Razin Effect

III. QUANTUM PROCESSES INVOLVING BOUND ELECTRONS

7. Emission and Absorption in Atomic Systems

7.1 Review of Basic Atomic Physics
7.2 Derivation of Radiative Transition Rates

8. Astrophysical Examples of Line Processes

8.1 Spectra of Gaseous Nebulae
8.2 Emission by Interstellar Molecules
8.3 Interstellar Absorption Lines

IV. RADIATION GAS DYNAMICS

9. Radiatively Driven Winds from Hot Stars

9.1 Radiation Force Due to Metal Lines
9.2 Castor's Stellar Wind Model
9.3 Application to an O5f Star

10. Protostar Accretion via Radiative Shocks

10.1 Initial Conditions for Protostar Collapse
10.2 Boundary Temperature of an Accreting Core
10.3 Radiative Transfer Across a Relaxation Layer

Optional Textbooks

Radiative Processes in Astrophysics by G. B. Rybicki & A. P. Lightman (1979)

The Physics of Astrophysics, Volume 1 (Radiation) & 2 (Gas Dynamics) by F. H. Shu (1991)

University of Toronto, Department of Astronomy

RADIATION PROCESSES
AST1440F

Evaluation Scheme for 2003

Term Begins:	*Monday, September 8*
Reading Week:	*not applicable in Fall*
Thanksgiving:	*Monday, October 13*
Term Ends:	*Friday, December 19*

1. CLASS PARTICIPATION 10%

2. TWO PROBLEM SETS 30%

Dates: i) ~ November 3
ii) ~ December 1

3. ONE SEMINAR (one hour) 30%

4. FINAL EXAM 30%

Date: i) ~ December 12

TOTAL 100%