Astronomy 5463 : Stellar Atmospheres

Eddie Baron
Office: 323 Nielsen Hall
Telephone: 325-3961 x 36323 (on campus 3-6323)
Office Hours: drop in and by appointment
Class Meets: MW 2:45 - 4:00, 203 NH

Text: *Radiative Transfer in Stellar Atmospheres* R. Rutten available on the Web, (you can print it from this local version or the original version. This is the most modern version of a book available for this course. I have used it in the past; however, I think it needs some supplementing.
Supplementary Text: *Stellar Atmospheres,* D. Mihalas, (New York: Freeman) 1977.
This book is out of print, but is in the library is available here (part 1) and here (part 2).

The purpose of this course is to give an introduction to the study of the physics of stellar atmospheres. I intend to approach this subject from a modern computational point of view, hence many of the homework problems will be computational in nature. If you don't know FORTRAN, now is the time to learn, there are many books available and I will help in any way I can. One book I can recommend is: *Fortran 95* Martin Counihan, (London: University College London Press) 1996.
Also IDL is a perfect tool for solving many of these problems. It is quicker to learn than Fortran and has many tools built right in. I encourage you to use IDL and to send me copies of codes you write in it.
A nice quick tutorial of IDL is available here from O'Connell at UVA.
If you use IDL you need to point to the extensive set of libraries that I have collected. *Don't copy them.* To point to these libraries automatically:
If you use the ksh add the following to your .profile file:

```
# shell script to set up the IDL environment variables and  aliases.
# first test if idl is installed
# the path will be system dependent
#
if [ -d /usr/local/itt ]; then
 . /usr/local/itt/idl/bin/idl_setup.ksh
elif [ -d /usr/local/rsi ]; then
 . /usr/local/rsi/idl/bin/idl_setup.ksh
fi
export IDL_PATH='<IDL_DEFAULT>':\+''$HOME''/idl_lib:\+/home/baron/idl_lib
```

The file is here.
If you use the csh add the following to the bottom of your .login file:

```
#
# add your own commands here
#
source /usr/local/itt/idl/bin/idl_setup.csh
setenv IDL_PATH '<IDL_DEFAULT>:+$HOME/idl_lib:+/home/baron/idl_lib'
```

The file is here.

The course requirements consist of class participation (10%), homeworks (40%), a midterm (20%), and a final project (30%). I will lecture in class, but I intend to ask a lot of questions and you will be expected to think about them during (and after class). The material in this class is highly technical and the old adage: *You don't really understand a subject until you do it* seems to hold. I will therefore assign a lot of homework problems. Stellar atmospheres is a bit like quantum mechanics in the "no one understands it."
The final project will consist of writing *and testing* a radiative transfer code using either the variable Eddington factor method, the accelerated lambda iteration method, or a Monte-Carlo method. The class will probably be split into several groups that will work together on the final project.

Note:
Any student in this course who has a disability that may prevent him or her from fully demonstrating his or her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your educational opportunities.

Course Topics

Date	Topic
Aug 23	Intro
Aug 25	Basic Radiative Transfer
	Intensity, Mean Intensity, Flux Emission, Extinction, Source Function Absorption coefficient: relationship of α_ν to κ_ν
Aug 25	Transport equation Optical depth Formal Solution Eddington–Barbier Approximation
Sep 3	Transitions Einstein Coefficients Formal Coefficients Continuum transitions
Sep 8	LTE and NLTE

Date	Topic
Sep 10	Two-Level atoms
Sep 13	Radiation Radiation as a wave Radiation as a gas
Sep 15	Transport equation in different geometries Moments
Sep 17	Exponential Integrals and Lambda Operator
Sep 20	Analytical Solutions at the Surface
Sep 22	Analytical Solutions at Depth
	Diffusion approximation Rosseland Mean Eddington Approximation
Sep 27	Interpretations of analytical solutions
Sep 29	Applications of analytical solutions
Oct 4	Numerical Solutions Feautrier Method
Oct 6	Lambda iteration Convergence
Oct 11	Accelerated Lambda Iteration
Oct 13	Complete Linearization
Oct 18	Midterm
Oct 20	Classical Modeling Limb darkening
Oct 25	Radiative Equilibrium Grey Problem
Oct 27	Line blanketing and NLTE effects
Nov 1	Spectra from Plane Parallel Models
	Profile functions and line broadening
Nov 3	Rate Equations
Nov 8-14	NLTE effects and the Sun (2 lectures)
Nov 10	Spectral Line Formation
Nov 15	Moving Atmospheres Eulerian Frame and Co-moving frame transport equation
Nov 17	Sobolev Theory
Nov 22	Unsöld-Lucy Methods for Radiative Equilibrium
Nov 29	Special Topics
Dec 1	Special Topics
Dec 6	Presentations
Dec 8	Presentations
Dec 10	Presentations (if necessary)