# Radiative Processes in Astrophysics
# Vt 2003, Computer Lab

Lab report due: Tuesday, May 6, 2003 at 10:15 a.m.

## 1 Introduction

By solving the equation of radiative transfer for a homogenous medium, one obtains the following equation:

$$I_\nu(D) \;=\; I_\nu(0)\, e^{-\tau_\nu(D)} + S_\nu^{tot}\left[1 - e^{-\tau_\nu(D)}\right]$$

where $\tau_\nu$ is the optical path and $D$ is the extension of the medium.

In these computer exercises, you will use a program that models an optically thin slab. By varying the incident intensity $I_\nu$, the source function $S_\nu$, the optical depth in the continuum $\tau_{cont}$ and the optical depth in the line $\tau_{line}$, you can illustrate different cases of spectral line formation in a homogenous slab.

## 2 Getting Started

The programs are written in the IDL language and are run in the IDL environment. You start up IDL by typing `idl` in the correct directory. The procedure is the following:

- User name: xxxxxx
- Password: xxxxxx
- type: `cd /u1/local/lab/stralningsprocesser/SlabLab`
- type: `idl`
  (if that does not work, try: `/usr/local/bin/idl_5.1`)

You will start up the computer simulation of radiative transport through a slab by typing the command `xslab`. The program is operated by sliders that will change the value of the corresponding variable. The `Help` button provides some elementary explanations. To exit, press `Done`.

## 3 Procedure

The aims of this exercise are to develop some intuition about this abstract topic, and to develop and then present your insights in a didactic way (maybe also correcting some possible misconceptions).

Begin by playing around with the sliders and trying to understand what is happening on the screen as a result. Then explore the possibilities more sytematically. Cover all the cases you can think of, and decide which ones are interesting. Use them to illustrate your presentation on absorption and line formation in the slab. Relate the plots to the equations we had in the lectures. (For example: How can you use the equations to interpret the plots qualitatively? Can you do a numerical check to show if the plotted values on the screen are correct?)

# 4 Lab Report

For the lab report, it may help to imagine the following situation. Your old friend Melvin (who recently gave up the movie business) has decided to study physics. He has taken Kjell's course so far, but this morning his computer exploded and he suffered a few minor scratches and burns. Now he has been waiting at the local clinic all day, unable to do the computer lab; but the deadline for the lab report is tomorrow. Being the good friend that you are, you go over to keep him company while he waits. Help him out by describing what the lab is like, and by giving him a lesson on what he needs to know about absorption and line formation in the slab.

Unfortunately, Melvin has not attended all the lectures and has a lot of misconceptions that you have to help him with. Try to think up the kinds of questions that Melvin might ask. (Feel free to be creative; the best "trick questions" may be included below next year as examples.) Here are just a few examples:

1. What did you see on the screen? What do all those things actually *mean*?
2. When a light beam passes through a slab of some kind of stuff, some of the light always gets absorbed so I must get less intensity on the other side, right?
3. Okay, so when exactly do you get an absorption line and when do you get an emission line? How does that work?
4. We heard in the lecture that the Eddington-Barbier approximation can be used to explain how an emission or absorption line is formed. Does that work here, too?

Take some time to formulate some good explanations...if not for Melvin, then for yourself. Good luck!

The software for this computer exercise was developed by Mats Carlsson and Oivind Wikstol at Institutt for Astrofysikk in Oslo. This lab is a distant mutant of the one written by Nils Ryde, Uppsala Astronomical Observatory, September 15, 1995.