Radiative Processes in Astrophysics
Problem Set 4

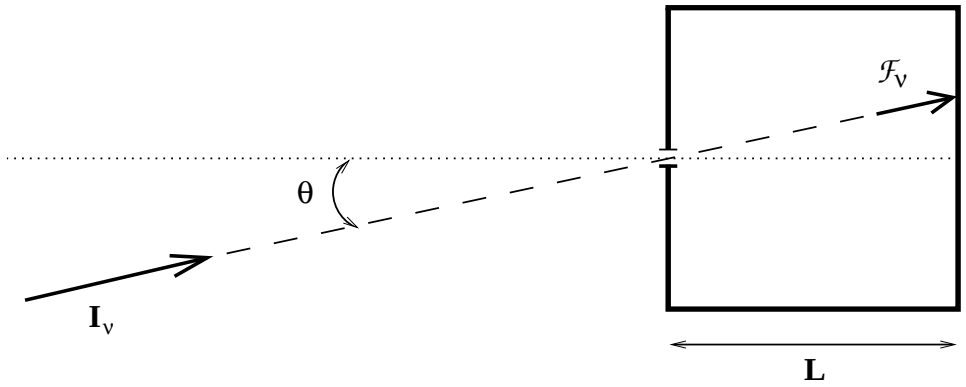
Due date: Tuesday, 2 April 2002

1. Pinhole camera

A "pinhole camera" consists of a small circular hole of diameter d, a distance L from the "film plane" (see figure below). Show that the flux $\mathcal{F}_\nu$ at the film plane depends on the intensity $I_\nu(\theta, \varphi)$ by

$$\mathcal{F}_\nu = \frac{\pi \cos^4 \theta}{4f^2} \, I_\nu(\theta, \varphi)$$

where $f = L/d$ is the focal ratio. This is a simple, if crude, method for estimating I_ν.



2. Plane-parallel atmospheres

(a) Why are plane-parallel layers often assumed for stellar atmospheres? Can you guess when this approximation is good and when not?

(b) We want to explain why the factor $\mu = \cos\theta$ enters into the radiative transport equation and its formal solution for plane-parallel atmospheres. Include a sketch showing the geometry. (When preparing your answer, look through what you wrote for question 2 from last time; where do you think is the best place to introduce the factor μ?)

3. Eddington-Barbier approximation and limb darkening

(a) What is the Eddington-Barbier approximation?

(b) What do we mean by "limb darkening"? Use Eddington-Barbier to explain this phenomenon.

(c) Pretend that you have measured limb darkening observationally. Show the plot(s) with which you would present your results. What would cause a limb *brightening* effect?