PROBLEM SET 2 [Due Tuesday, January 22]

Physics 210– Computational Physics

The goals of this problem set are (i) to write a program to solve the one dimensional diffusion equation numerically; and (ii) to explore a couple of non-trivial applications.

Write a program to solve the one dimensional diffusion equation

$$\frac{\partial \psi}{\partial t} = D \frac{\partial^2 \psi}{\partial x^2} \tag{1}$$

numerically. Test it by showing that the discrete analog of

$$\int_{-\infty}^{+\infty} dx \ \psi(x,t) \tag{2}$$

is conserved (independent of t).

Use your program to study diffusion when D is not constant. Specifically, start out with a concentrated region of particles near the origin and set $D = D_1$ for $x > 0$ and $D = D_2$ for $x < 0$. Make a plot of $\psi(x,t)$ for some appropriately large t which compares the cases $D_1 = D_2$ and $D_1 = 10D_2$.

You are given two bars of length L. One is at temperature T_1 and the other at temperature T_2. Place them in contact (that is, form a bar of length 2L running from $-L < x < L$) at $t = 0$, and show how the temperature equilibrates as t progresses. Assume that the ends of the combined bar at $x = \pm L$ are insulating, so no heat escapes those ends. (The contact point of the two bars at $x = 0$ we assume is *not* insulating, of course.)