Physics 360/Math 360 MWF 11:00 - 11:50 PM, Room: Dennis 231

Instructor: Michael Lerner, Dennis 221, Phone: 727-LERNERM

Assignment 7, Due Monday April 7th

1 The wave equation

1.1 Additional problem

Argue that the wave equation is a reasonable physical model for waves. You may make this argument for 1D, 2D, or 3D waves. Does it seem reasonable for both longitudinal and transverse waves? You may use the book, the internet, or whatever resources you'd like, but make sure to cite your sources.

1.2 Boas §13.1

Boas 13.1.2

2 Diffusion/Heat Flow; Schrodinger

2.1 Boas §13.2

13.2.3, 13.2.7

2.2 Boas §13.3

13.3.1; you must also write down the rest of the answer to Example 1. It's perfectly fine to use the book as a reference *before* you write you answer, but I want you to write it out in your final form without looking at the book.

3 Steady State Temp in a Rectangular Plate

3.1 Additional problem

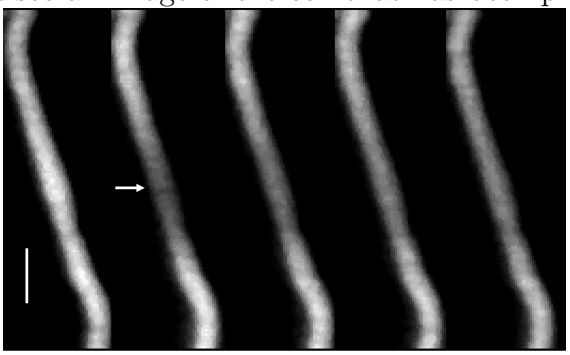
Most of the problems we've been solving involve an infinite number of terms in the solution. With appropriate boundary conditions, this is not required. Solve the semi-infinite rectangular plate problem with one side of the plate held at

$$T = \sin\left(\frac{-2\pi x}{L}\right) + \cos\left(\frac{3\pi x}{L}\right) \tag{1}$$

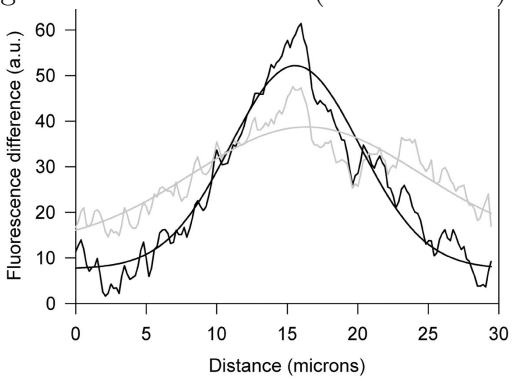
How many terms do you find in your solution, a finite number, or an infinite number? If it's finite, why should that be true conceptually? If it's infinite, why should that be true conceptually?

4 FRAP (Adapted from "Physical Biology of the Cell", Ch. 13)

In biology, one often wants to know how quickly various molecules are moving. The standard way of performing these experiments under a wide variety of experimental settings is with Fluorescence Recovery After Photobleaching (FRAP). In the figure below[1], an elongated *E. coli* cell with TorA-GFP (a protein fused with green fluorescent protein) is shown on the far left. A TorA-GPF loses its fluorescent properties when you shine a strong laser on it ("photobleaching"). In the second frame, you see an image of the cell that has been photobleached at the site indicated by the arrow.



As fluorescent proteins from *outside* that area diffuse in (frames 1s to 3s), the bleached area becomes more fluorescent. By measuring the rate at which the fluorescence returns, you can find out how quickly the proteins are diffusing within the cell. The image below shows the difference in fluorescence immediately after bleaching (dark jagged line) and 4 seconds after (light jagged line), along with fits to the data (smooth lines).



Your goal is to write down an equation modeling the concentration of protein over time. We'll split this problem up into two weeks. This week: what PDE will you use to model the system? What are your initial conditions? What are your boundary conditions? Will you be expanding your solution in terms of sin or cos functions?

5 Boas §13.4 (waves on a string)

13.4.2, 13.4.12 (Due Wednesday)

[1] C. W. Mulineaux et al., J. Baceriol. 188:3442,2006