Homework Assignment 2
Physics 212

Handed out:	Monday, January 25, 1999
Due in class on:	Monday, February 1, 1999

Problem 1: Young's Two-Slit Experiment with Polarized Light

Pages 88-92 of French and Taylor, as well as many introductory physics text books, discusses Thomas Young's famous two-slit experiment of 1801, in which he showed that light had to have wave-like properties since there were interference effects. Note: the Maxwell equations came nearly fifty years later, so Young had little theoretical guidance on what to expect.

Now consider the following variation of the 2-slit experiment (refer to Figure 2-24 on page 91 of French and Taylor). A linear z-polarizer is placed just in front of hole S_1 and a linear z' polarizer, tilted at an angle θ with respect to the z-axis, is placed in front of hole S_2. (The x- and y-axes lie in the plane of the page while the z-axis points out of the page; the z' polarizer is rotated in the $z-y$ plane so that $\theta = \pi/2$ corresponds to the y-axis.)

1. For the angle $\theta = \pi/2$, the two beams of light are transversely polarized (z and y). Draw a picture of the light intensity $I(y)$ as a function of y along the observation wall and explain clearly why no interference effects are observed in this case. As we discussed in class, this elegant simple observation by Young provided powerful proof that light involved oscillations transverse to its direction of motion.

2. By drawing several more $I(y)$ intensity curves for other values of the angle θ, explain how the intensity curve changes as a function of angle θ.

Problem 2: Flaw in Figure 6A-14 on page 265?

Figure 6A-14 on page 265 of French and Taylor shows one design for an RL analyzer. I argue that this figure is flawed in that the quarter-wave plate on the right side is not needed. Here is my reasoning: since the calcite crystal is an xy analyzer, if the arbitrary incident beam enters directly into the calcite crystal, all photons must appear in either the x or y channels. The ideal quarter-wave plate on the left side only shifts phases and doesn't absorb any photons and so converts all photons in the x and y channels to L- and R-polarized photons. Thus the calcite crystal plus left quarter-wave plate, as a single device, converts an arbitrary beam from the right into R- and L-channels without loss of photons and so is an RL analyzer.

Who is right, French and Taylor or myself? Please explain your answer in detail.

Problem 3: Problems in French and Taylor

Please do the following problems in the French and Taylor book. Since some brief answers are given in the back of the book, your answers should provide the reasoning and details.

1. Problem 7-7 on pages 308-309.

2. Problem 7-9 on pages 309-310.

3. Problem 7-10 on pages 310-311.

4. Problem 10-2 on page 464.

5. Problem 10-4 on page 465.
6. Problem 10-5 on pages 465-466.

Problem 4: Problem 3.57 of Griffiths

Please do Problem 3.57 on pages 118-119 of Griffiths. Please also determine whether the operator $|\alpha\rangle\langle\alpha|$ is Hermitian.

Problem 5: Two Quiz Problems On Chapters 7 and 10

Please invent and write down two short quiz problems *with solutions*, concerning the material discussed in class and in Chapters 7 and 10 of the French and Taylor book, covering quantum amplitudes and the Stern-Gerlach apparatus. As before, your quiz problems should be similar in style and in length to the ones that you saw in Physics 211, testing conceptual understanding or some important technical point. At next Monday's class (February 1), we'll choose and discuss some of your quiz problems.

Problem 6: Time for Completion

Please tell me the approximate time in hours that it took to finish this assignment.