Physics 47 — Optics

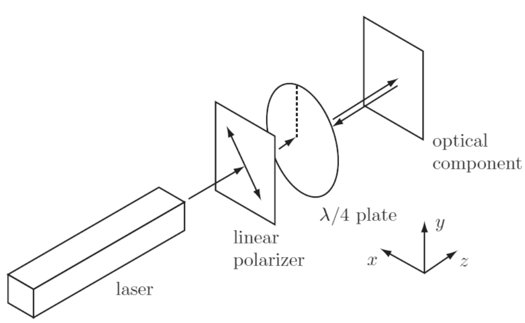
Problem Set 5
Due Fri, Oct 20, 2017
(before start of class)

Textbook Problems

1. Hecht 8.26 [4 pts.]
2. Hecht 8.42 [3 pts.]
3. Hecht 8.55 [5 pts.]

Additional Problems

A1. [8 pts.] – The physical arrangement of optics shown below to the right is sometimes used to prevent backscattered light from causing *bad things*™ to happen to a laser. Light from the laser is first incident on a linear polarizer that is oriented with its polarization axis making an angle of 45° with respect to the x axis, as shown. The light then enters a $\lambda/4$-plate with its fast axis orented vertically, before entering some other (unspecified) optical component. Almost all optical components reflect at least a small part of the incoming beam (remember the Fresnel equations). The light is normally incident on all the items in the diagram.



a) Assume that the laser produces a beam with an electric field given by

$$\mathbf{E}(z,t) = E_0(\hat{x} + \hat{y})e^{i(kz-\omega t)}$$

Show that the light exiting the $\lambda/4$ plate is circularly polarized by finding the form of its electric field.

(*continued on back*)

b) Consider light *reflected* by the last (unspecified) optical component, which is not birefringent. This light will be circularly polarized with opposite handedness compared to the incident light. Why? (Hint: invoke a fundamental conservation principle.) Give the form of the electric field for the reflected beam.

c) What happens to the reflected beam when it goes back through the "circular polarizer"? (Explicitly calculate what occurs by finding the electric field of the beam as it goes backward through the $\lambda/4$ plate and linear polarizer).

A2. [2 pts.] – This problem is more of a puzzle for you to figure out than a computational task: Suppose you have a laser beam parallel to the optical table, and the light polarization is perpendicular to the table. You need light that is polarized parallel to the table. How can you do this using only two mirrors? (And without turning the laser on its side!) Note, it doesn't matter which way the laser beam is propagating after you're done.

The solution to this puzzle is very important for wavelengths where there is no suitable birefringent material for making a transparent $\lambda/2$ plate (e.g. deep UV wavelengths), or for broadband lasers when dispersion of the transmitted light is unacceptable (femtosecond pulsed lasers).