Phys 531 Assignment 10 Due November 29

1. When left-circularly polarized light is normally incident on a surface, what is the polarization of the reflected wave? (Your result should hold for both internal and external incidence.)

2. Consider an elliptically polarized wave with

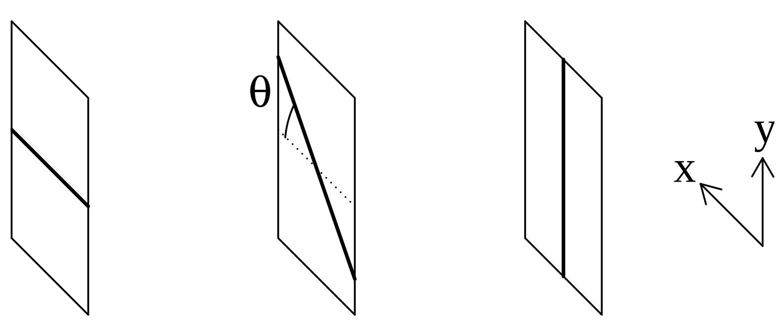
$$\hat{\jmath} = \frac{1}{\sqrt{3}}\,\hat{\mathbf{x}} + e^{i\pi/4}\sqrt{\frac{2}{3}}\,\hat{\mathbf{y}}$$

(a) Use the formulas given in class to calculate the angle α and the eccentricity e of the ellipse traced out by $\mathbf{E}$.
(b) Suppose the wave is incident on an ideal polarizer with transmission axis at an angle θ to the x-axis. Numerically plot the transmission T as a function of θ and find: (*i*) the angle θ_{max} at which the transmission is a maximum, (*ii*) the angle θ_{min} at which it is a minimum, and (*iii*) the ratio of the maximum to minimum transmission values. Compare to the results of (a).

3. (a) Consider unpolarized light with irradiance I_0 incident on a set of three ideal linear polarizers as shown. The first polarizer has its transmission axis along x, the second at an angle θ from the x axis, and the third along y. Calculate the transmitted irradiance as a function of θ, and find the maximum possible transmission.

(b) Answer the same questions if the middle polarizer is replaced by an ideal quarter-wave plate with fast axis at angle θ.

(c) Answer the same questions if the middle polarizer is replaced by an ideal half-wave plate with fast axis at angle θ.



4. Quartz is a uniaxial crystal with $n_e = 1.5517$ and $n_o = 1.5426$. Use quartz to design a quarter-wave plate for light with wavelength $\lambda = 633$ nm. However, assume that you can't cut the plate any thinner than 0.5 mm, so it will need to be a multiple-order waveplate. What is the minimum thickness (consistent with this constraint) that will work? Give at least three significant digits.

Using this thickness, what would be the retardance (in waves) for light at $\lambda = 650$ nm?

5. Suppose left-circularly polarized light is incident on a quarter wave plate with fast axis at an angle θ to the x-axis. Show that the output is linearly polarized and find the polarization angle α.

6. Express the rotation matrix

$$\mathcal{R}(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

in the basis of the circular-polarized states $\hat{\mathbf{e}}_{\mathcal{R}}$ and $\hat{\mathbf{e}}_{\mathcal{L}}$.