Phys 531 Assignment 9 Due November 18

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

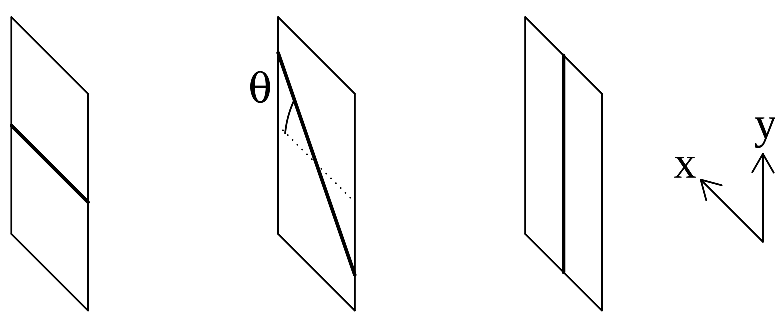
$$\hat{\jmath} = \frac{1}{\sqrt{3}}\,\hat{\mathbf{x}} + e^{i\pi/4}\sqrt{\frac{2}{3}}\,\hat{\mathbf{y}}$$

(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 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. What angle gives the highest transmission, and what is the value of this transmission?

(b) What is the transmission if the second polarizer is replaced by a quarter-wave plate with fast axis at angle $\theta = 45°$?

(c) What if the second polarizer is replaced by a half-wave plate with fast axis at 45°?



4. Quartz is a positive uniaxial crystal with $n_e = 1.553$ and $n_o = 1.544$. For what thicknesses does a quartz plate act as a quarter-wave retarder at $\lambda = 633$ 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 $\hat{\mathbf{e}}_{\mathcal{L}}$.