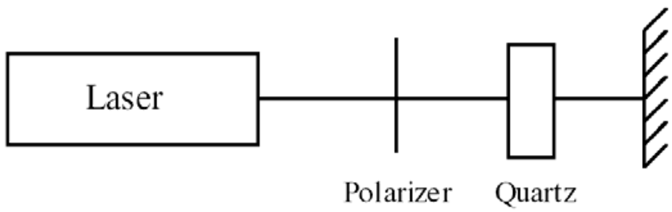
WP-C1) A quartz plate in the setup shown below has its axes at 45 degrees relative to the transmission axis of the linear polarizer. The indices of refraction for quartz are no=1.544 and ne=1.553. The laser wavelength is 633 nm.

a) What is the minimum quartz thickness for having no light reflected back to the laser?

b) What is the minimum quartz thickness (other than zero) for having the maximum amount of light reflected back to the laser?



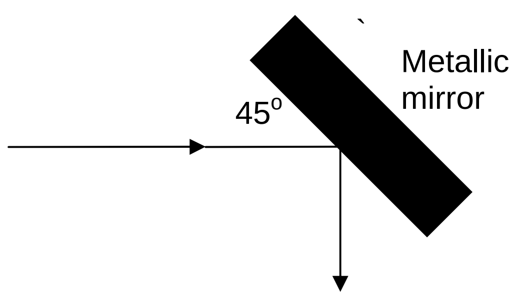
WP-C2) A left-hand circularly polarized laser beam illuminates the metallic mirror as shown below. The angle of incidence on the mirror is 45°. The Fresnel equations given below describe the reflection coefficient for *s* and *p* polarized light as a function of the angle of incidence, and the index of refraction of the metal is N_t = 1.49+7.82j. (This is the coefficient for Al at 650 nm).

a.) Draw the locus plot (trace of the tip of the electric vector in a plane perpendicular to the direction of propagation) for the electric vector after reflection from the mirror. (Hint: Use program pol_locus_plot.m after you have determined the state.)

b.) What is the state of polarization after reflection from the mirror? (Include a calculation of the ellipticity and the rotation angle θ of the major axis.

$$r_p = \frac{-N_t \cos\theta_i + N_i \cos\theta_t}{N_t \cos\theta_i + N_i \cos\theta_t}$$

$$r_s = \frac{N_i \cos\theta_i - N_t \cos\theta_t}{N_i \cos\theta_i + N_t \cos\theta_t}$$

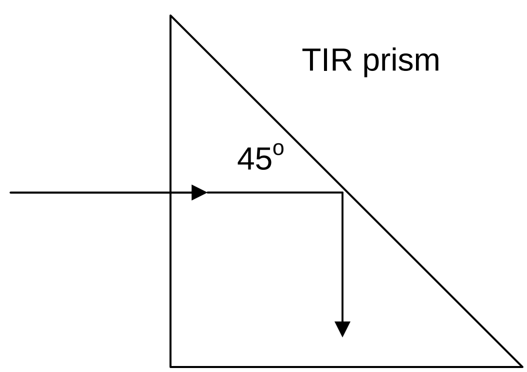


WP-C3) A left-hand circularly polarized laser beam illuminates the total-internal reflection prism as shown below. The angle of incidence on the turning surface is 45^o. The Fresnel equations given below describe the reflection coefficient for *s* and *p* polarized light as a function of the angle of incidence, and the index of refraction of the glass is $N_i = 1.5$. Assume that the prism is in air with $N_t = 1$ and ignore effects of the entrance and exit surfaces of the prism.

a.) Draw the locus plot (trace of the tip of the electric vector in a plane perpendicular to the direction of propagation) for the electric vector after reflection from the turning surface. (Hint: Use program pol_locus_plot.m after you have determined the state.)

b.) What is the state of polarization after reflection from the turning surface? (Include a calculation of the ellipticity and the rotation angle θ of the major axis.)

$$r_p = \frac{-N_t \cos\theta_i + N_i \cos\theta_t}{N_t \cos\theta_i + N_i \cos\theta_t}$$
$$r_s = \frac{N_i \cos\theta_i - N_t \cos\theta_t}{N_i \cos\theta_i + N_t \cos\theta_t}$$



WP-C4) We showed in class that the complex index of refraction can be thought of as resulting from a classical mass-spring-damper system a form similar to:[1]

[1] This is a little different form than what was presented in class.

$$N = \sqrt{1 + \frac{\text{constant}}{\omega_{01}^2 - \omega^2 - j2\omega\xi}} \quad ,$$

where the constant contains terms related to the electronic charge, mass and molecular concentration. ω_{01} is the resonant frequency, ξ is the damping term, and ω is the driving frequency. Consider the case where the resonant wavelength is 0.3 μm, constant = $3 \times 10^{31} s^{-2}$ and $\xi = 1.5 \times 10^{15} s^{-1}$. Graph the real and imaginary parts of the index of refraction for the wavelength range between 0.2 μm and 0.8 μm.

WP-C5) A plane wave travels in air with direction cosines given by $(\alpha,\beta) = (0.3,0)$. The maximum amplitude of the electric field is 1 V/m and the wavelength is 0.5μm.

a.) Plot the electric field amplitude as a function of position along the line $(0,0,z)$ for several periods of the wave at $t = 0$.

b.) What is the velocity of the wave crest projection (peak of the electric field amplitude) that travels in this direction?

WP-C6) A 0.6328 μm wavelength spherical point source is used to approximate plane-wave illumination on a 1 mm diameter aperture. How far must the point source be located away from the aperture if the maximum allowed deviation from a plane wavefront is 1/100 wave over the diameter of the aperture?

WP-C7) Two plane waves in air are traveling in the same direction. Wavelengths of the two waves in air are $\lambda_1 = 589.3$ nm and $\lambda_1 = 589.4$ nm.

a.) What is the beat frequency in Hz? Comment on the practicality of detecting this beat frequency if the maximum available detector bandwidth is 10^9 Hz.

b.) What are the velocities of the modulation and high-frequency components?

c.) If the waves travel in an optical glass with an Abbe number V = 45, does the answer to (b) change significantly?[2]

[2] The Abbe number V is a measure of the change of refractive index versus wavelength, where $V = (n_D-1)/(n_F-n_C)$. n_D is the refractive index at λ= 589.3 nm, n_F is the refractive index at λ= 486.1 nm and n_C is the refractive index at λ= 656.3 nm.