University of Calgary
Winter semester 2007

PHYS 471: Optics

Homework assignment 4

Due March 14, 2007

Problem 4.1. A laser beam is sent into a Michaelson interferometer. Determine the interference visibility if a quarter wave plate is placed into one of the interferometer arms so the polarization becomes circular (Fig. 1). Splitting is equal.

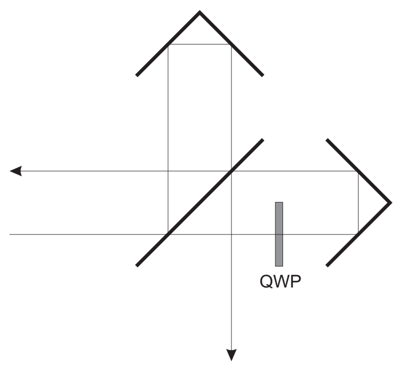

Figure 1: diagram for Problem 4.1

Problem 4.2. A Fabry-Perot cavity is formed by two mirrors of reflectivity r^2 (such that $1 - r^2 \ll 1$) situated at distance l from each other. Inside the cavity, there is an attenuator with intensity absorption $L \ll 1$. Find the FWHM linewidth of the cavity in terms of the optical frequency ω as well as the minimum and maximum cavity transmission coefficients. **Hint:** an absorber can be modeled as a beam splitter with transmission L and reflectivity $1 - L$.

Problem 4.3. Light from a white source is filtered with a monochromator and sent into a Michaelson interferometer. The transmission of the monochromator $T(\lambda)$ is a Gaussian function of the wavelength with a FWHM of $\delta\lambda = 1$ Å centered at $\lambda = 795$ nm.

a) Find $T(\lambda)$.

b) Find the transmission function $T(\omega)$ of the monochromator in terms of the optical frequency. Find its FHWM $\delta\omega$. **Hint:** because $\delta\lambda$ is small, you can assume a linear relation between ω and λ in the region where $T(\lambda)$ is substantially nonzero.

c) Find the interference pattern $I(x)$ at the output of the interferometer as a function of the path length difference x. Find the visibility as a function of x.

d) Estimate the coherence time τ_c of your source based on the value of x at which the visibility drops by a factor of 2. Verify the relation $\tau_c \times \delta\omega \sim 1$.

Problem 4.4. Find the Jones matrix associated with a circularly birefringent crystal of length L and refraction indices n_R and n_L, respectively, for the left and right circular polarizations. Verify that the matrix you found is equivalent to the two-dimensional rotation matrix.