PHYS 251: Atomic Physics Lab
Due date (before or at start of lab): Sept. 11, 2024 (Wednesday section)
Sept. 12, 2024 (Thursday section)

Pre-Lab Exercise: Optical Interferometry

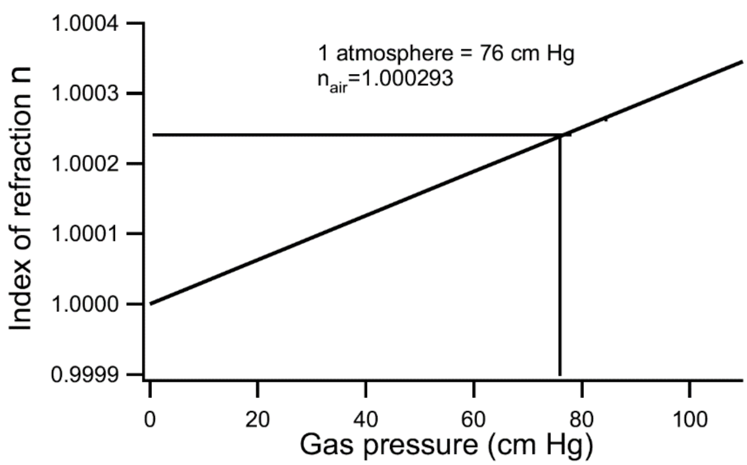
Problem: Index of refraction of air

The "Optical Interferometry" lab manual explains that you will use optical fringe counting with your Michelson interferometer to determine the index of refraction of air n_{air}.

(a) Equation 5 of the lab manual (page 7) states the change in the index of refraction Δn is given by $\Delta n = \Delta m(\lambda_0/2d_{cell})$, where λ_0 is the wavelength of the laser in vacuum, and d_{cell} is the length of the air cell (nominally $d_{cell} = 3.0$ cm). Here, Δm is the change in the number of interferometer fringes as the air pressure is varied (and thus the index of refraction of the air is varied).

Derive equation 5 from the basic interference equation, $\Delta L = m\lambda$, and the information in the lab manual. Here, ΔL is the difference (or change) in the optical path length between the two arms of the interferometer (see eq. 3 and also p. 3), and m is the number of fringes.

(b) The lab manual gives the following plot for the relationship between the index of refraction of the air in the cell and the air pressure (see Fig. 4):



In the lab you will measure the change in interferometer fringes Δm as the air pressure p is varied.

*Derive an expression for Δm as a function of the pressure p and make a computer-generated **plot** that shows the variation Δm as the pressure is varied over the range $0 < p < 100$ cm Hg.*

Note: You should use $\lambda_0 = 650$ nm for making the plot.