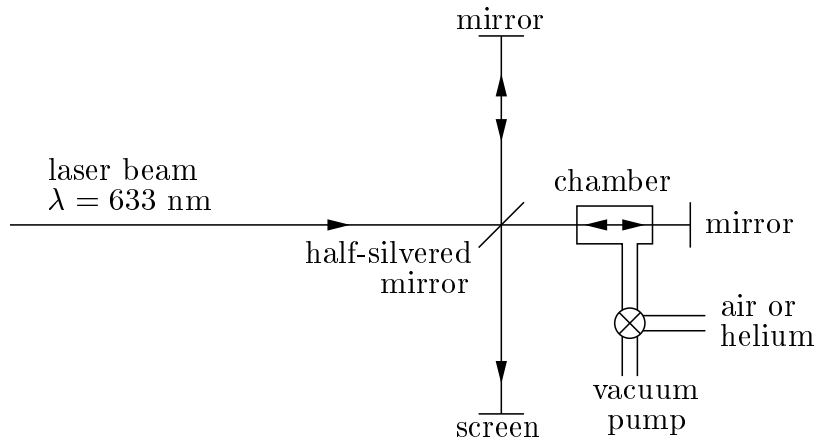


Nov 9 to 15

In this lab, you will use a Michelson interferometer to measure the index of refraction of a gas. A chamber which can be evacuated is placed in one arm of the interferometer. All of the air is first evacuated from the chamber. As the gas to be studied is slowly allowed to enter the chamber, the number of fringes passing by the center of the screen is counted.



The index of refraction n of the gas is given by

$$n = 1 + \frac{N\lambda}{2L},$$

where N is the number of fringes counted, λ is the wavelength of the laser in vacuum, and L is the length of the chamber.

Turn on the vacuum pump and evacuate the chamber. Pump for at least a couple of minutes to obtain a good vacuum. Valve off the vacuum pump and *slowly* open the chamber to air and count the fringes. (You will probably open the valve too fast the first time you try, and the fringes will go by too quickly to count. If this happens, evacuate the chamber again and start over.) Repeat using helium gas instead of air. Measure L and calculate n for each gas.

	Air	Helium
$L =$	_____	_____
$N =$	_____	_____
$n =$	_____	_____

Physics 123 section 2
Supplement to Lab #8
Michelson Interferometer

When the chamber is evacuated, the number of wavelengths along its length L is given by

$$N_{\text{vac}} = \frac{L}{\lambda_{\text{vac}}}, \quad (1)$$

where λ_{vac} is the wavelength of the laser light in vacuum. When the chamber is filled with some gas, the number of wavelengths along its length is now given by

$$N_{\text{gas}} = \frac{L}{\lambda_{\text{gas}}}, \quad (2)$$

where λ_{gas} is the wavelength of the laser light in the gas.

Each time one arm of the interferometer gets behind (or ahead) by one wavelength, one fringe passes by the screen. As we fill the chamber with gas, that arm of the interferometer will get behind by $N = 2(N_{\text{gas}} - N_{\text{vac}})$ wavelengths. (The factor 2 is included since the light passes through the chamber twice, once going and once coming back.) From equations (1) and (2), we thus obtain

$$N = 2 \left(\frac{L}{\lambda_{\text{gas}}} - \frac{L}{\lambda_{\text{vac}}} \right). \quad (3)$$

We also know that

$$\lambda_{\text{gas}} = \frac{\lambda_{\text{vac}}}{n},$$

where n is the index of refraction of the gas. Putting this into equation (3) solving for n , we obtain

$$n = 1 + \frac{N\lambda_{\text{vac}}}{2L}.$$