THE INDEX OF REFRACTION OF GLASS*

INTRODUCTION

One method to measure the index of refraction of glass is to slowly vary the length of glass through which the interferometer beam passes. This experiment introduces a technique for making such a measurement.

In principle, the method for calculating the index of refraction is relatively straight forward. The light passes through a greater length of glass as the plate is rotated. One thus determines the change in path length of the light beam as the glass plate is rotated. Then determine how much of this change in path length is through glass $d_g(\theta)$ and how much is through air $d_a(\theta)$. The relationship between the measured fringe transitions (N) and the change in path length is given by

$$N = \frac{2n_a d_a(\theta) + 2n_g d_g(\theta)}{\lambda_o} \qquad (1),$$

where n_a = index of refraction of air,
n_g = index of refraction of glass plate, and
λ_o = wavelength of the light source in vacuum.

It can then be shown that for a plate of thickness t, the index of refraction is given by

$$n_g = \frac{(2t - N\lambda_o)(1-\cos\theta)}{2t\,(1-\cos\theta) - N\lambda_o} \qquad (2),$$

{Light Principles and Measurements, Monk,McGraw-Hill, 1937.}

PROCEDURE

1 Align the laser and interferometer in the Michelson mode. See Figure 1.

2. Place the rotating table between the beam-splitter and movable mirror, perpendicular to the optical path.

* Taken from PASCO Scientific laboratory write-ups

NOTE: if the movable mirror is too far forward, the rotating table won't fit. You may need to loosen the thumbscrew and slide the mirror farther back.

3. Mount the glass plate on the magnetic backing of the rotational pointer.

4. Position the pointer so that its "0" edge on the Vernier scale is lined up with the zero on the degree scale on the interferometer base.

5. Remove the lens from in front of the laser. Hold the viewing screen between the glass plate and the movable mirror. If there is one bright dot and some secondary dots on the viewing screen, adjust the angle of the rotating table until there is one bright dot only. Then realign the pointer scale. The plate should now be perpendicular to the optical path.

6. Replace the viewing screen and the lens and make any minor adjustments that are necessary to get a clear set of fringes on the viewing screen.

7. Slowly rotate the table by moving the lever arm. Count the number of fringe transitions that occur as you rotate the table from 0 degrees to an angle θ = 5 degrees.

8. Repeat the procedure above for rotations of θ through 0 to 10 degrees, 0 through 15 degrees and 0 through 20 degrees.

DATA ANALYSIS

Complete Table 1 below. Determine the average value of the index of refraction for the glass plate and the standard deviation in this value.

Table 1: Experiment Results for Index of Glass Plate

Trial	θ max (degrees)	N	n_g
1			
2			
3			
4			
Average			
Standard Deviation			

QUESTIONS:

1. Explain any trends or differences for the four difference measurements you made, i.e. $0<\theta<5$, $0<\theta<10$, $0<\theta<15$, and $0<\theta<20$. Is it better to use a small angle or a large angle of this experiment? Why?

2. Starting with equation 1, derive equation 2.

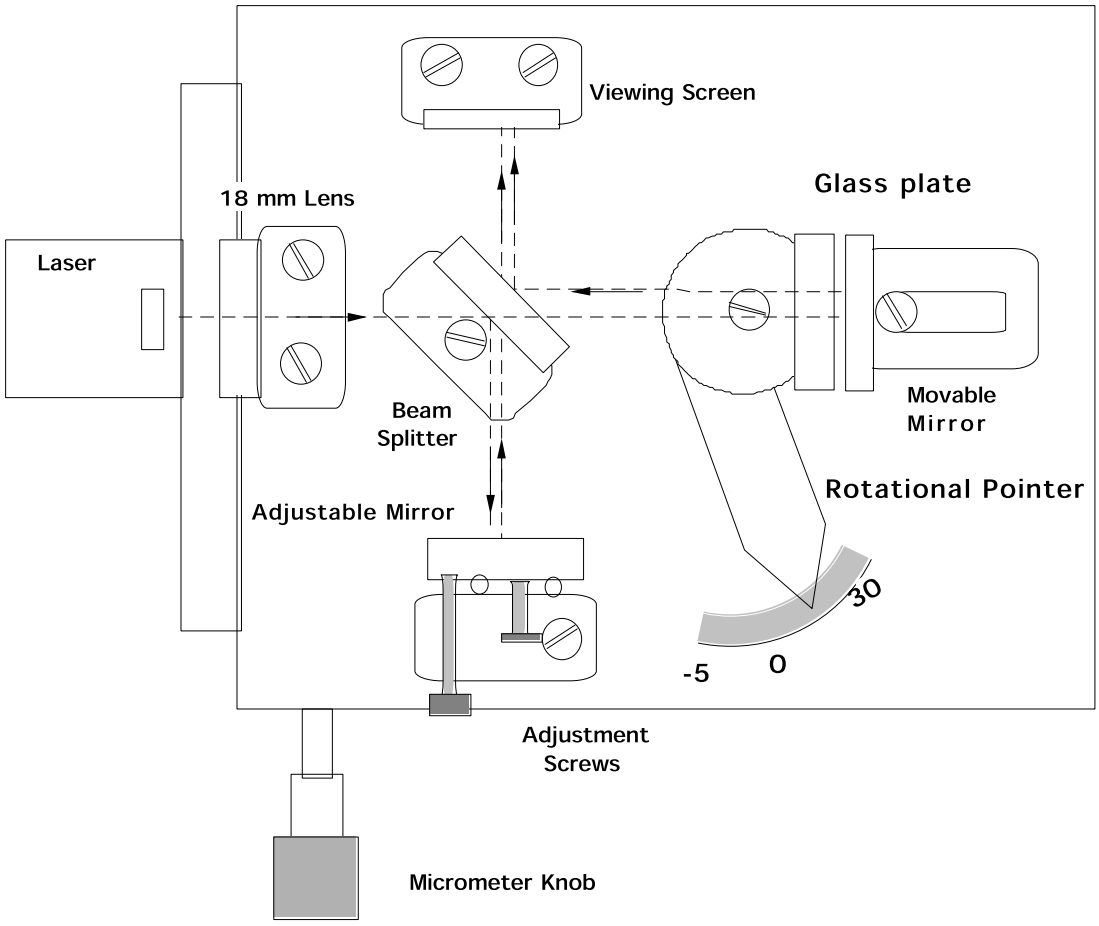

Figure 1. Experimental Layout