INTERFEROMETRY: MEASUREMENT OF WAVELENGTH*

INTRODUCTION

In general, an interferometer can be used in two (2) ways. If the characteristics of the light source are accurately known (wavelength, polarization, intensity), changes in the beam path can be introduced and the effects on the interference pattern can be analyzed. On the other hand, by introducing specific changes in the beam path, information can be obtained about the light source that is being used. In this experiment, you will use the interferometer to measure the wavelength of your light source (laser).

In the interferometer arrangement, the distance that the movable mirror moved toward the beam-splitter is given by d_m. If N fringe transitions are observed in the diffraction pattern, as the position of the "movable" mirror is changed, then the wavelength of the light source is given by

$$\lambda = 2d_m/N \quad (1)$$

PROCEDURE

1. Align the laser and interferometer in the Michelson mode, so an interference pattern is clearly visible on your viewing screen. See Figure 1.

2. Adjust the micrometer knob to a medium (approximately 50 μm). In this position, the relationship between the micrometer reading and the mirror movement is most nearly linear.

3. Turn the micrometer knob one full turn counterclockwise. Continue turning counterclockwise until the zero on the knob is aligned with the index mark. Record the micrometer reading.

   NOTE: When you reverse the direction in which you turn the micrometer knob, there is a small amount of give before the mirror

* Taken from PASCO Scientific laboratory write-ups

begins to move. This is called mechanical backlash, and is present in all mechanical systems involving reversals in direction of movement. By beginning with a full counterclockwise turn, and then turning only counterclockwise when counting fringes, you can eliminate errors due to backlash.

4. Adjust the position of the viewing screen so that one of the marks on the millimeter scale is aligned with one of the fringes in your interference pattern. You will find it easier to count the fringes if the reference mark is one or two fringes out from the center of the pattern.

5. Rotate the micrometer knob slowly counterclockwise. Count the fringes as they pass your reference mark. Continue until some predetermined number of fringes have passed your mark. (Count 20 fringes for your first trial.). As you finish your count, the fringes should be in the same position with respect to your reference mark as they were when you started to count. Record the final reading of the micrometer dial.

6. Record d_m, the distance that the movable mirror moved toward the beam-splitter according to your readings of the micrometer knob. Each small division on the micrometer knob corresponds to one µm (10^{-6} meters) of mirror movement.

7. Record N, the number of fringe transitions that you counted.

8. Repeat steps 3 through 7 five times, increasing N by 5 counts each time.

Analysis

For each trial, calculate the wavelength of the light, using equation (1), then average your results. Complete the data table below. Determine the Average and standard deviation of the data. Compare your results for the wavelength to the known wavelength for the laser used in the experiment.

Table 1. Wavelength Determination

Trail	N	d_m (μm)	λ (μm)
1			
2			
3			
4			
5			
Average			
Standard Deviation			
% error			

Questions

1. In the calculation to determine the value of λ based on the micrometer movement, why was d_m multiplied by two?

2. Why move the mirror through many fringe transitions instead of just one? Why take several measurements and average the results?

3. If the wavelength of your light source is accurately known, compare your results with the known value. If there is a difference, to what do you attribute it?

4. When measuring mirror movement using the micrometer dial on the interferometer, what factors limit the accuracy of your measurement?

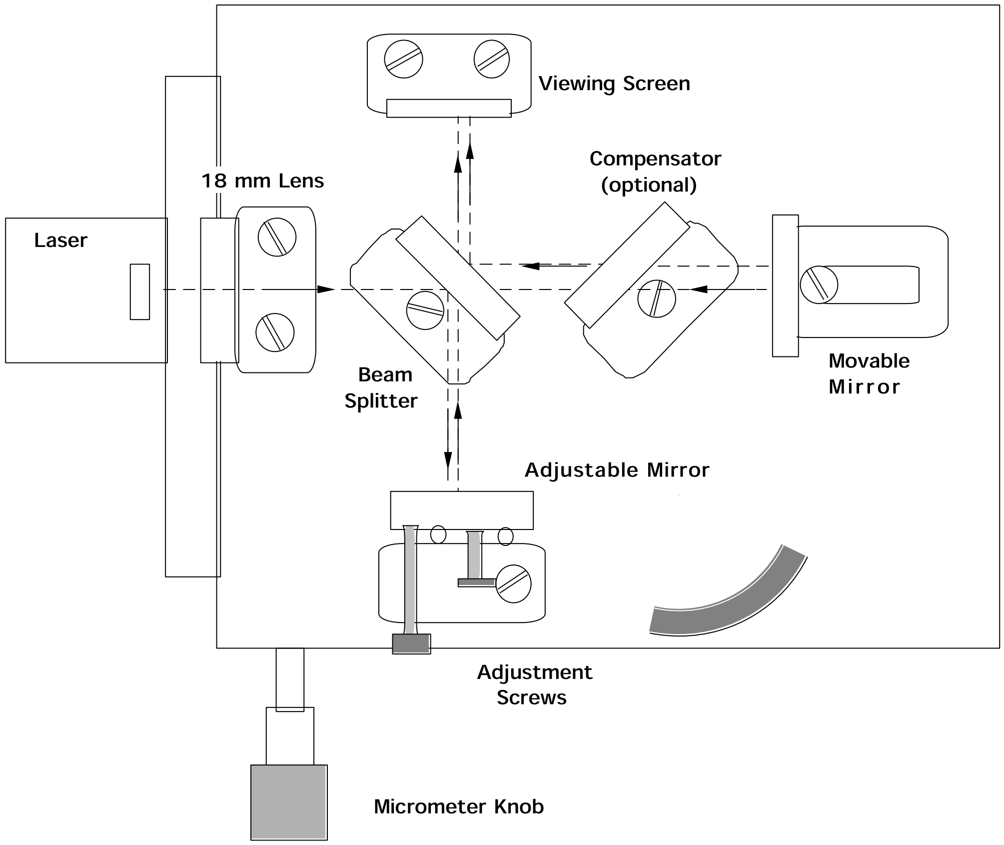

Figure 1. Experimental Layout

Figure 2. Experimental Setup