Laboratory room F10313 : Interference

Objectives

- To learn about the interference of light by using Michelson Interferometer
- To measure the wavelength of laser source from an interference pattern

Theoretical Discussion

The **Michelson interferometer** (invented by the American physicist Albert A. Michelson, 1852–1931) is a precision instrument that produces interference fringes. As shown in Figure 1, the red laser with the wavelength of $\lambda = 632.8\ nm$ is split into two parts by using the beam splitter

Figure 1 depicts the interferometer and the path of a light beam from a laser source. To generate the interference fringe, one of the split beam (path #1) will pass through the beam splitter to the fixed mirror, then reflected back to the beam splitter. The reflected light from fixed mirror will then reflect at the beam splitter to the viewing screen. The other beam path #2 which is reflected from beam splitter will travel to movable mirror, then reflected back to the beam splitter. The reflected beam from the movable mirror will pass through the beam splitter to the viewing screen. Thus, the interference occurs on the viewing screen is due to the superposition of the light beam from path #1 and path #2. The interference fringe (dark and bright rings) on the viewing screen causes by the different in an optical path these two light beams.

By changing the optical path different of these two beams, the position of dark ring and bright ring on the screen will be changed. This optical path different can be adjusted by moving the movable mirror using the micrometer. Moving distance of the movable mirror can be measure from $d_1 - d_2$ when the micrometer is adjusted from the position d_1 to d_2. At the central position of interference fringe, the bright spot will be occurred when the optical waves from two paths are constructive interference while the dark spot will be occurred when it is a destructive interference. Thus, if the moving distance of movable mirror is equal to nλ (n = 1, 2, 3,...), the central spot in the interference fringe on the screen will be changed from bright to bright or dark to dark. When Δm is the number of the change from bright spot to bright spot or dark spot to dark spot in the interference fringe, the relationship between the optical path different $2(d_2 - d_1)$ and the wavelength of light source can be defined as:

$$2(d_2 - d_1) = (\Delta m)\lambda$$

Where Δm = 1 when the central spot is changed from bright to bright or dark to dark.

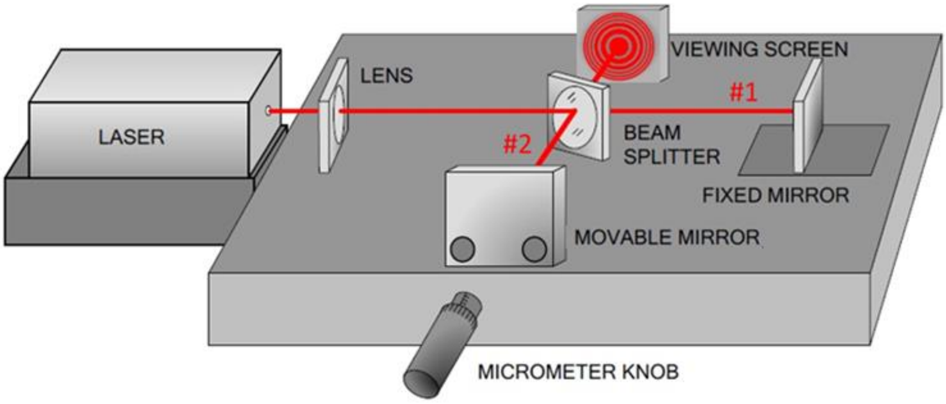

Figure 1 Experimental setup for producing the interference pattern from Michelson interferometer.

Worksheet and Quizs : Laboratory 6 (Interference from Michelson Interferometer)

Name____Student ID _______________Group__________

Experiment summary table

Counting the interference fringes which move by a reference point from bright circle to dark circle or dark circle to bright circle.

Number of fringes Δm	The initial reading on the micrometer $d_1(\mu\text{m})$ Reading error=______	The final reading on the micrometer d_2 (μm) Reading error=______	Moving distance of the moving mirror $2d_{\Delta m} = 2(d_2 - d_1)$ (μm) Error=________

Plot the graph of the experimental results when Y-axis is $2d_{\Delta m}$ and X-axis is Δm

[Present the calculation of slope and error from the slope in the graph. Then, report the calculated result below.]

Slope from the graph ____

Y-intercept in the graph ____

So that the wavelength of laser used in this experiment is _________________________________

Post-class Quizs: You have 2 minutes

Please consider the provided photos and/or equation, then answer the questions below:

1. From the images of interference pattern, what is the path different between each arm of the interferometer? (Answer the question in terms of $m\lambda$ or $(\left(m+\frac{1}{2}\right)\lambda)$ when m is an integer)

   Answer ____

2. From the equation $2(d_2 - d_1) = (\Delta m)\lambda$, please find $2(d_2 - d_1)$ when the change of an interference pattern is ordered from image 1 to 4. Noted that the wavelength of laser used in this experiment is 640 nm.

   Answer ____

Total score (2)

0 score when all answers are wrong.

1 score when part of answers are correct.

2 score when all answers are correct.