2OS3: Michelson Interferometer

Equipment:

No.	Material	OrderNo.	Quantity
1	He/Ne Laser, 5mW with holder	08701-00	1
2	Power supply for laser head 5 mW	08702-93	1
3	Interferometer plate w precision drive	08715-00	1
4	Optical base plate with rubber feet	08700-00	1
5	Photoelement f. opt. base plt.	08734-00	1
6	Adjusting support 35 x 35 mm	08711-00	4
7	Surface mirror 30 x 30 mm	08711-01	4
8	Beam splitter 1/1, non-polarizing	08741-00	1
9	Holder f.diaphr./beam splitter	08719-00	1
10	DMM, auto range, NiCr-Ni thermocouple	07123-00	1
11	Lens holder f.optical base plate	08723-00	1
12	Lens, mounted, f +20 mm	08018-01	1
13	Magnetic foot for optical base plate	08710-00	6
14	Screen, white, 150 x 150 mm	09826-00	1
15	Measuring tape, l = 2 m	09936-00	1

Task

Construction of a Michelson interferometer using separate components. The interferometer is used to determine the wavelength of the laser light. The contrast function, *K,* is qualitatively recorded in order to determine the coherence length.

Setup and procedure

Before starting the experiment, make sure you read LASER SAFETY guidelines.

Numbers in brackets refer to coordinates on the optical base plate in accordance with Fig. 1, as a rough guide. The recommended setup height (beam path height) is 130 mm.

A) The Michelson interferometer is setup as the following:

1. Remove lens L [1,7] for initial adjustments. Make sure lines on the extra plate P line up with the lines on the optical base. Make sure M1 [1,8] and M2 [1,4] is aligned with the 4^{th} y-coordinate of the base plate.

2. Remove the beam splitter BS [7,4]. Adjust mirror M3 [10,4] to have the reflected beam on the same point on mirror M2 from which it previously originated.

3. Place the beam splitter BS with its metalised side facing mirror M2. The partial beam should strike mirror M3 unchanged and another partial beam strike mirror M4 [7,1] perpendicularly along the 7^{th} x coordinate of the base plate.

4. Adjust mirror screw on mirror M4 so that the beam strikes the same point on screen SC [7,6.5] with the partial beam from mirror M3 that was also reflected from BS.

5. Place lens L[1,7] in the beam path and observe the interference pattern on screen SC.

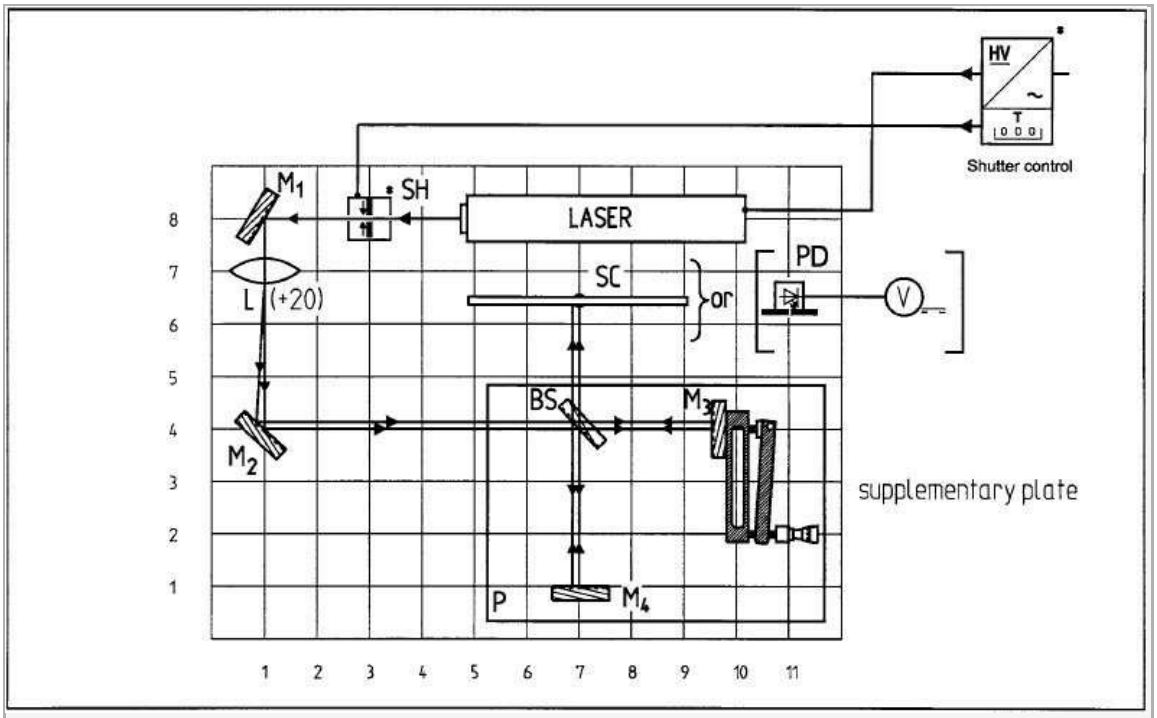

Fig. 1. Experimental set-up of the

B) Wavelength determination measurement:

1. To determine the wavelength of light, the path distance between M3 and BS must be changed. The position of M3 is altered using a lever arm and a micrometer screw (2 turns correspond to 1 mm).

2. Record initial micrometer value. Then turn the micrometer while counting upto 30 fringes. Finally, record the final micrometer value.

3. Repeat step 2 for 50 and 70 fringes.

4. Calculate the wavelength of light and compare with the actual value.

C) Determining coherence length by contrast function:

1. Replace the screen SC by a photo diode PD. Make sure the centre of fringe is at the centre of the PD.

2. The room should be kept as dark as possible to keep the dark current of the PD as low as possible.

3. Measure and record the minima and maxima intensities. Change if intensities can be obtained using the micrometer screw. The minima and maxima reading is obtained from multimeter that is attached to the PD.

4. Measure the distance between mirrors (M3 and M4) and BS with a measuring tape and record this value.

5. Next, repeat step 3 at different optical separations. This is done by moving M4 (along y-coordinate only).

6. The difference in optical path length between the two mirrors and the beam splitter should be varied between 0 and 10 cm.

7. Notice the larger separation differences are, the smaller the radii of the circular interference fringes are. Consequently, at large separation differences the measurement of the maximum and minimum intensities is uncertain and as a result, subject to large errors.

8. Calculate the contrast function, $K = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$.

9. Plot the value of K against d (optical path shift) and determine the coherence length.

VIVA questions:

1. What is the equation for determining wavelength of light?
2. Define the coherence length.
3. How is the coherence length measured by a Michelson interferometer? (may refer: https://en.wikipedia.org/wiki/Coherence_length)
4. Laser safety.

LASER SAFETY TIPS

1. Locate beam at waist level or below. Don’t place beam at eye level.
2. Close and cover your eyes when stooping down around the beam (where you will pass by the beam at eye level).
3. When leaning over a table, beware of beam directed upward.
4. Don’t direct beam toward doors or windows.
5. Terminate beams or reflections with beam with fire-resistant beam stops. Anodized aluminum or aluminum painted black (which is not necessarily fire- resistant) can work well for this purpose.
6. Use surfaces that minimize specular reflections.
7. Don’t wear watches or reflective jewellery.
8. Don’t wear neckties around Class 4 open beam lasers.
9. The eye is a soft tissue, don’t stare directly into the beam at eye level.