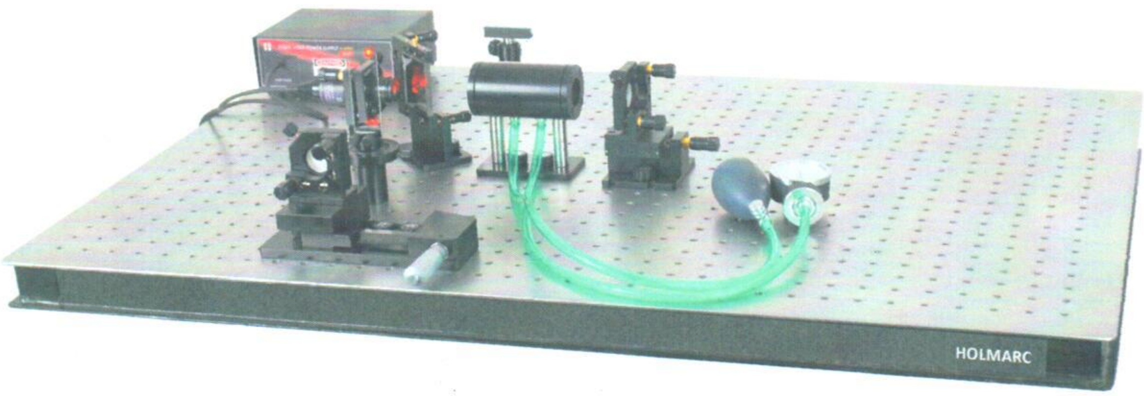
Instruction Manual



Michelson Interferometer

Model: HO-ED-INT-06

CONTENT

Page

:: Items included

1. Optical Bread Board with Support

Model No: HO-ED-BB-03

Size : 800mm x 600mm

Quantity : 1no.

2. Kinematic Laser Mount

Model No: HO-ED-KLM-01

Fine adjustments : Using 80 tpi leadscrews

Adjustment Range : +/-4 degrees

Material : Black anodized Aluminum alloy

3. Beam splitter Mount

Model No: HO-ED-BSM-01

Quantity : 1no.

4. Mirror Mount with Translation

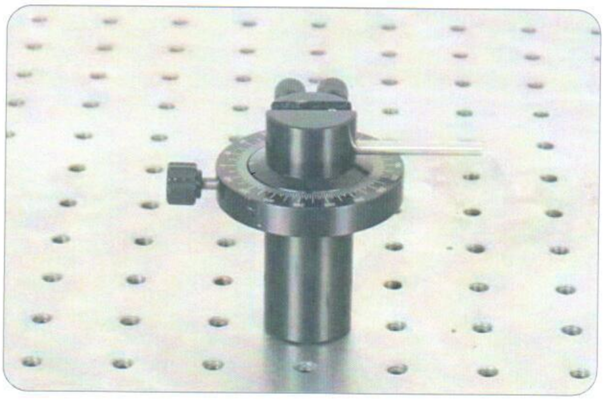
Model No: HO-ED-MM-01
Quantity : 1no.

5. Mirror Mount with Precision Translation

Model No: HO-EK-MMPT-02
Least count of the micrometer: 0.01mm
Quantity : 1no.

6. Rotation Stage

Model No: HO-ED-RS-01
Resolution : 2°
Quantity : 1no.

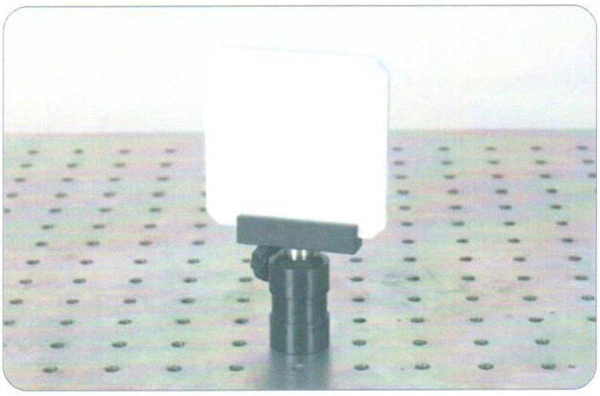


7. Pressure Cell

Model No: HO-ED-PC-01
Length : 10 cm
Max Pressure : 300mm Hg
Quantity : 1no.

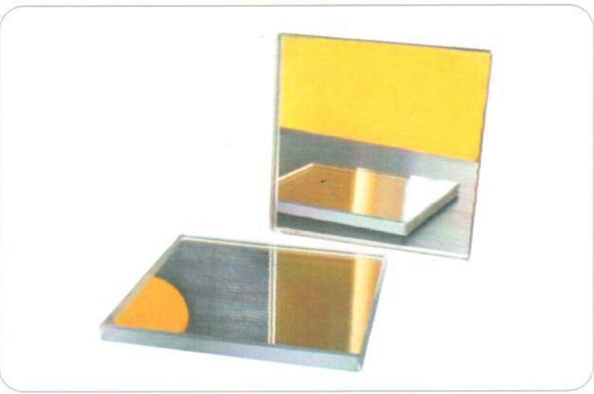
8. White Screen with mount

Model No: HO-ED-WS-01
Quantity : 1no.

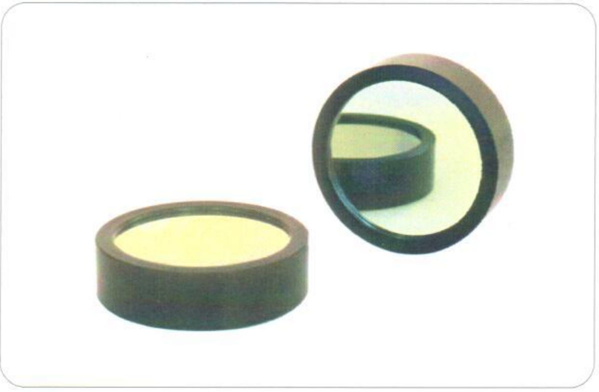


9. Beamsplitter

Model No: HO-PSBS-50
Dimension: 50mm X 50mm
Thickness: 4mm
R/T ratio : 50/50
Material: Bk7
Coating: Aluminum



10. Mirror



Model No: HO-PCMA-25

Diameter : 25mm

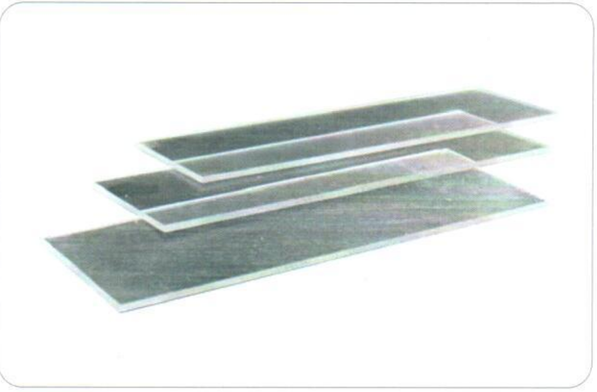
Thickness: 6mm

Material: Borofloat

Coating : Protected Aluminium

Quantity : 2 nos.

11. Glass Slide



Model No: HO-GS-01

Quantity : 5no.

12. Diode Laser with Power supply (Red)

Model No: HO-DLD-R-5

Wave length : 650nm

Input : 230V AC / 50 Hz

Optical power : 5mw

Quantity : 1no.

13. **Diode Laser with Power supply (Green)**

Model No: HO-DLD-G-5

Wave length : 532nm

Input : 230V AC / 50 Hz

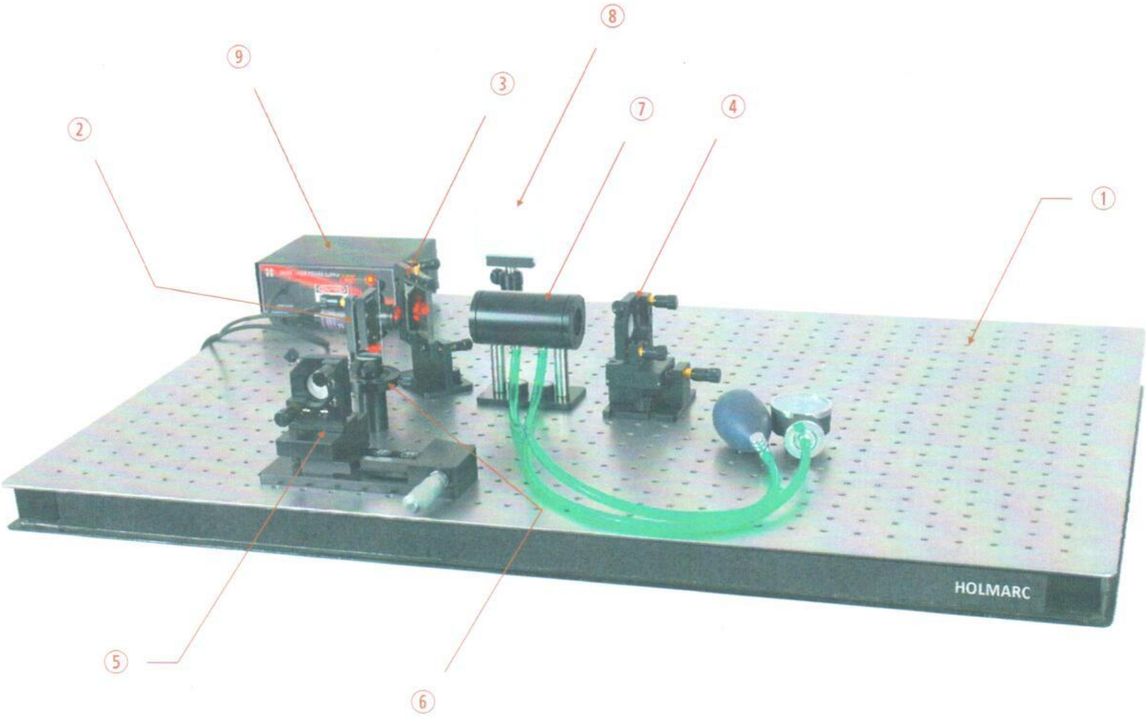
Optical power : 5mw

Quantity : 1no.

b. Safety and Installation Instructions

- Laser radiation predominantly causes injury via thermal effects; avoid looking directly into the laser beam.
- It is best that students work in low light dust free atmosphere.
- Care must be taken while handling the Optical components since this experiment uses precision and high quality Optical Components.
- Please don't put your fingers on the main optical surfaces but hold components by their edge.
- Always keep the equipment in a moisture and dust free atmosphere.

c. Parts Listing :

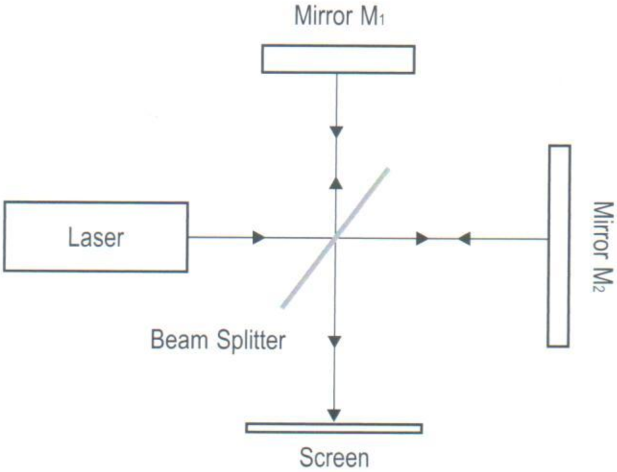


1. Optical Breadboard with Support
2. Kinematic Laser Mount
3. Beamsplitter with Mount
4. Mirror Mount with translation
5. Mirror Mount with Precision Translation
6. Rotation Stage with Glass Slide
7. Pressure Cell
8. White Screen with mount
9. Diode Laser with Power supply (Red)

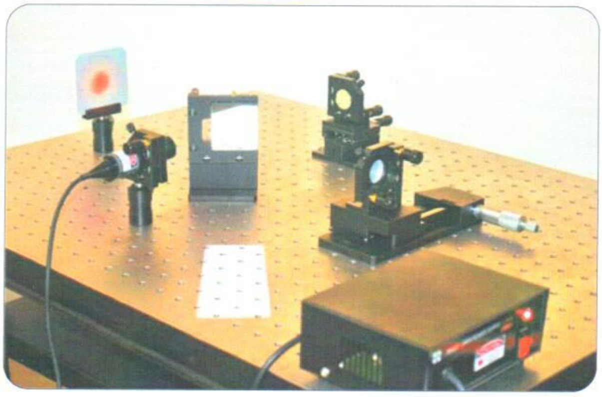
Wave Length of Laser Beam

Theory :

M_1 and M_2 are two plane mirrors silvered on the front surfaces. They are mounted vertically on two translation stages placed at the sides of an optical platform. Screws are provided at the back of the holders, adjusting of which allows M_1 and M_2 to be tilted. M_1 can also be moved horizontally by a leadscrew attached to the M_1 holder.



The beam splitter, a planar glass plate partially silvered (50% - 50%) on one side. It is mounted vertically at an angle 45° to the incident light. When light from laser is allowed to fall on the beam splitter, one portion is transmitted through the beam splitter to M_1 and the other is reflected by beam splitter to M_2. The reflected beams from M_1 and M_2 superimpose at the beam splitter and interference pattern can be observed on the screen.



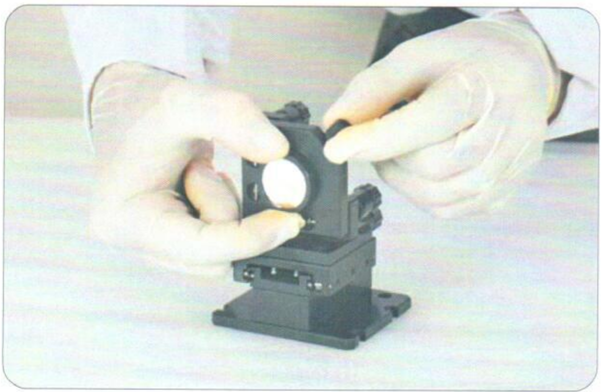
The wavelength of laser is calculated by:

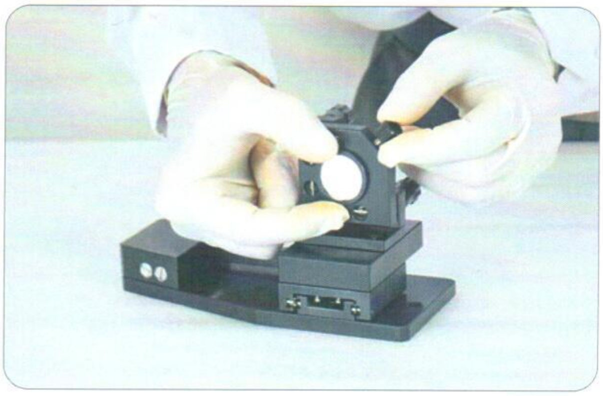
$$\lambda = (2d / N)\, \Delta$$

where 'd' is the change in position that occurs for 'N' fringes to pass and Δ is the calibration constant of the micrometer

:: Preparation for the experiment

Inserting optics in the mounts:

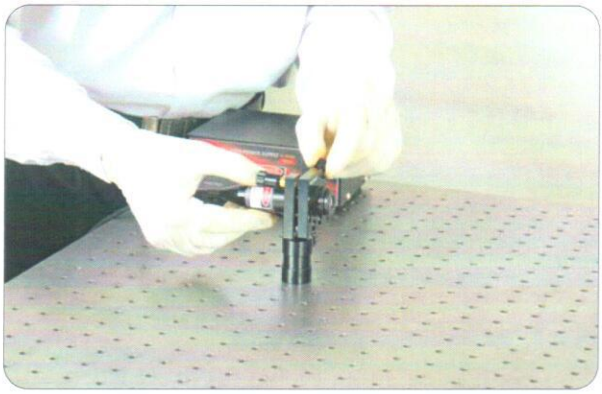




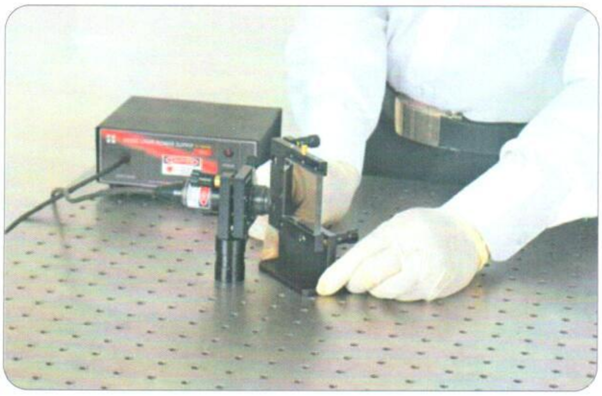
Mirror is inserted in two types of mirror mounts, mirror mount with translation and mirror mount with precision translation.

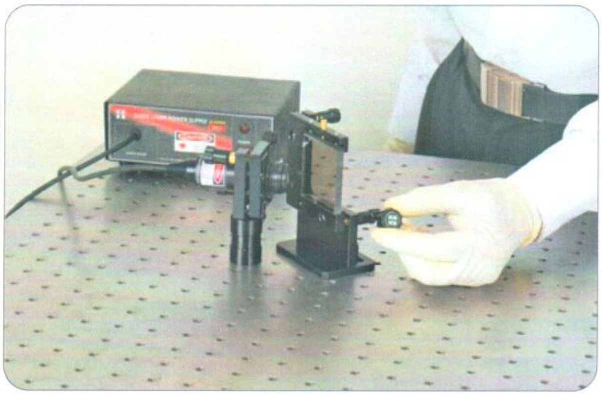
Inserting beam splitter in the mount. Care should be taken while placing the beam splitter. Insert it in a manner that coated face of the beam splitter will come in front of the mount.

Construction of Michelson Interferometer :

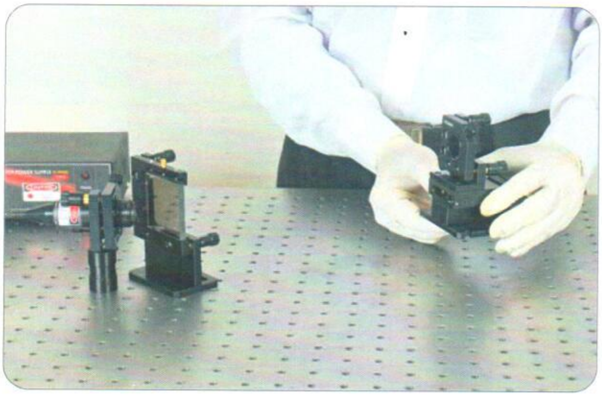
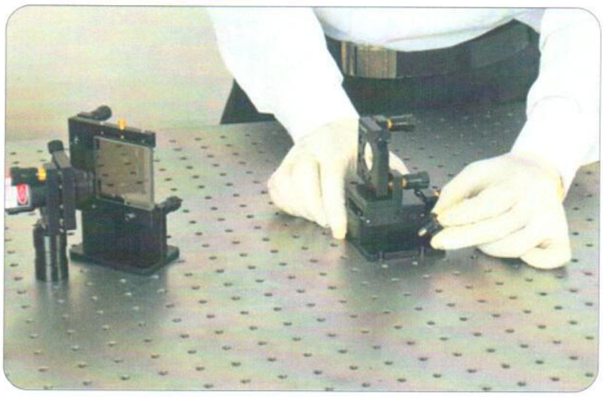


For the setting of Michelson Interferometer, first we are placing laser mount on the bread board. Then, insert laser module into the mount.

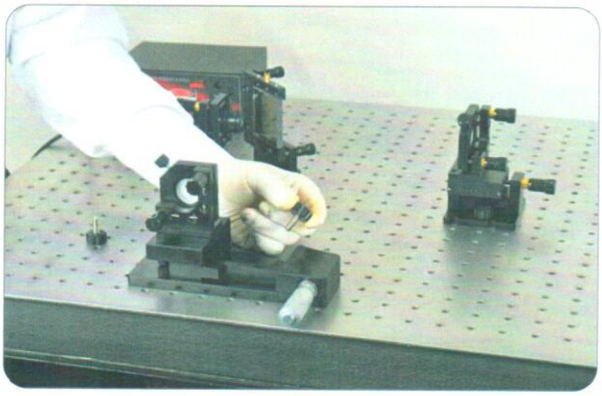
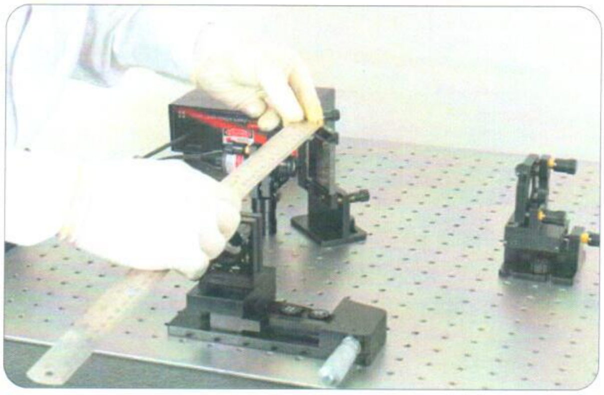




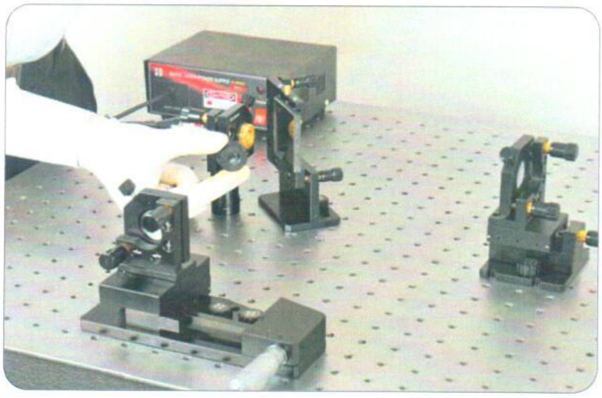
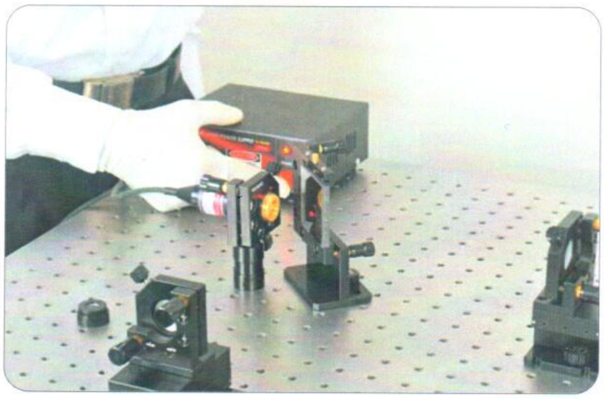
Place the beamsplitter in front of the laser source with an inclination of 45 degree and fix it with thumb screws.

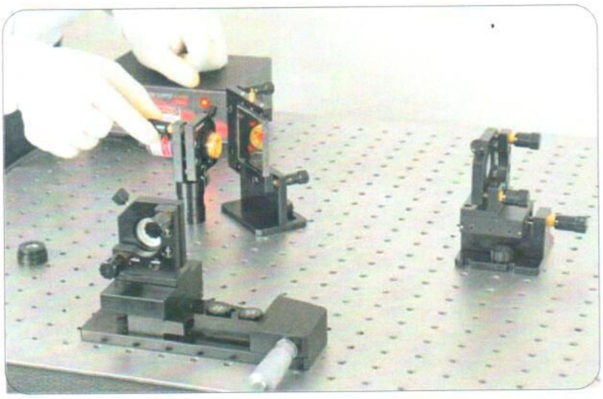
Place mirror with translation at a distance straight to the laser source and fix it with thumb screws.

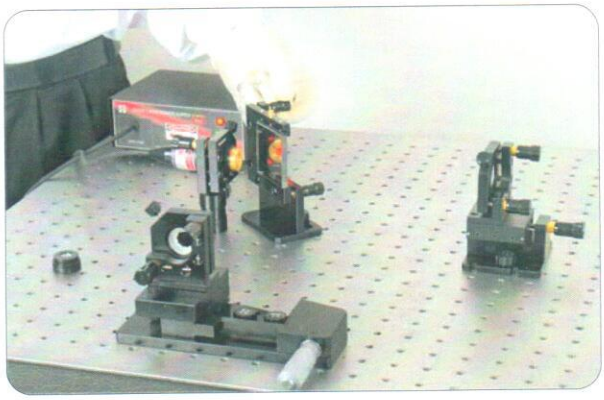



Now place the mirror with precision translation in perpendicular position to the first mirror. Make sure that the distance between two mirrors from the center of beam splitter is nearly equal. Fix it with thumb screws.

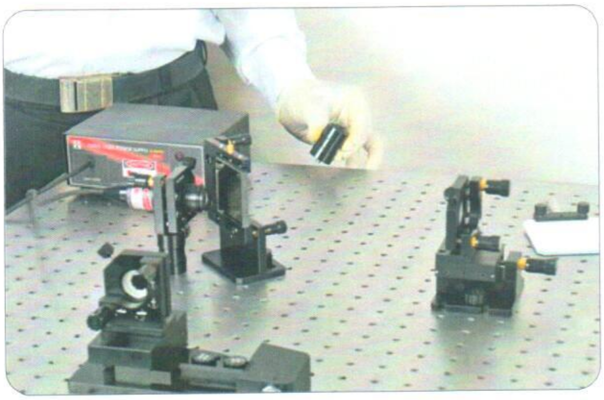



Remove the divergence lens from the laser module. Switch on the laser power supply.

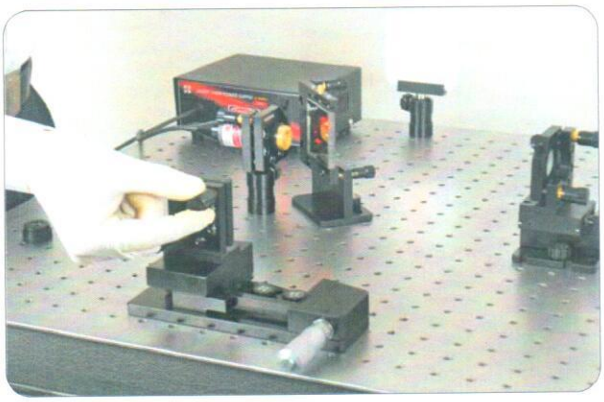


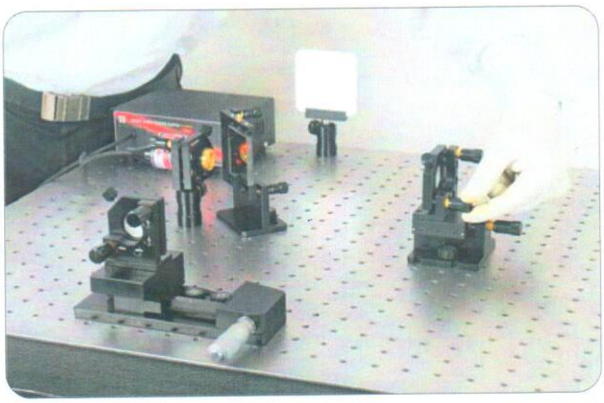


Make the laser beam straight in order to fall at the center of the first mirror. Tilt the beam splitter for getting the beam spot at the center of the second mirror.

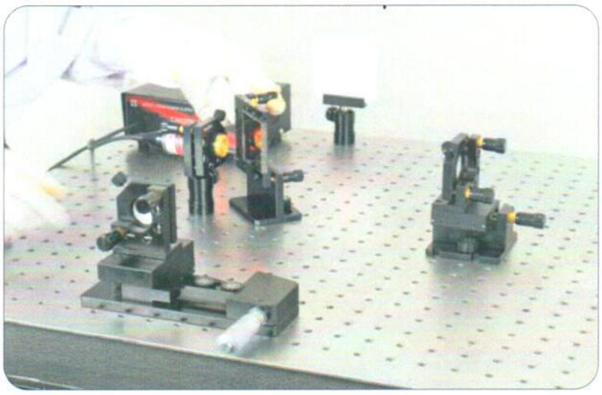


Now place the screen in order to collect the beam spot straight to the second mirror.



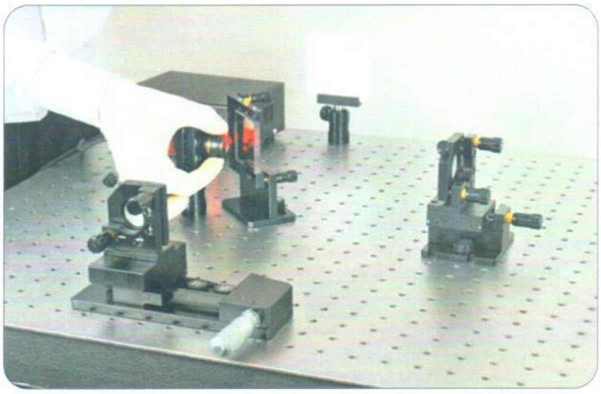


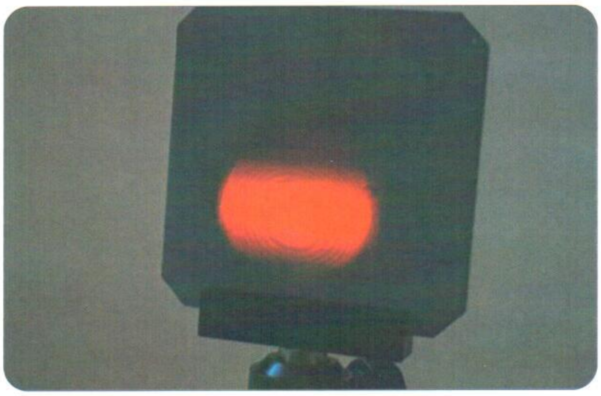
Align the mounts to get the spot at the center of the beam splitter. Try to coincide the reflected beam spots at the beam splitter first.



After that only, align the beam splitter mount in order to coincide the laser spots at the screen.

If the beam spots are exactly coincided, then we can observe a small part of the fringe pattern or some flickering at that coincided part.





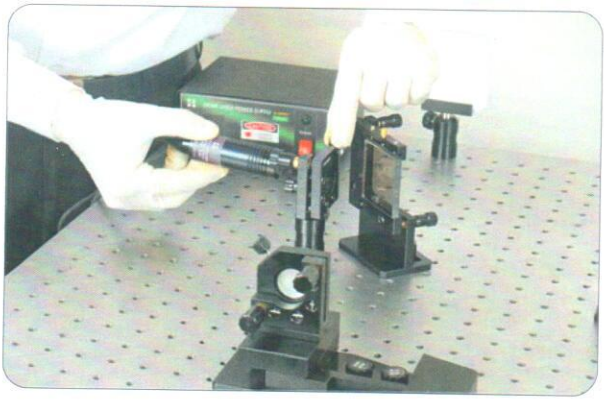
Now place the divergence lens back to the laser module in order to get an expanded beam profile. We can see the fringe pattern on the screen. Tilt the mounts to get the center of fringe pattern.

Make the pattern much more clear by adjusting the path length. For that, adjust the course movement of mirror with translation to and fro.

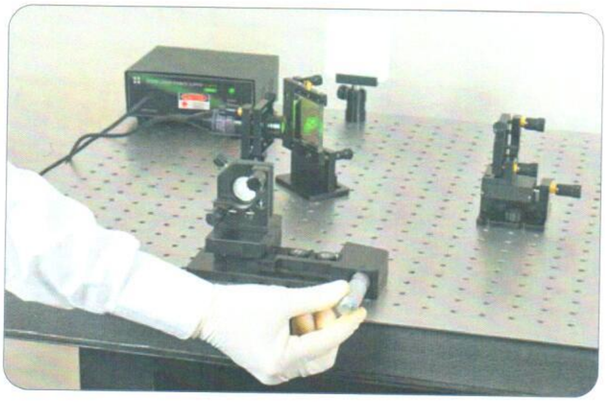
Now we can observe clear fringes on the screen.

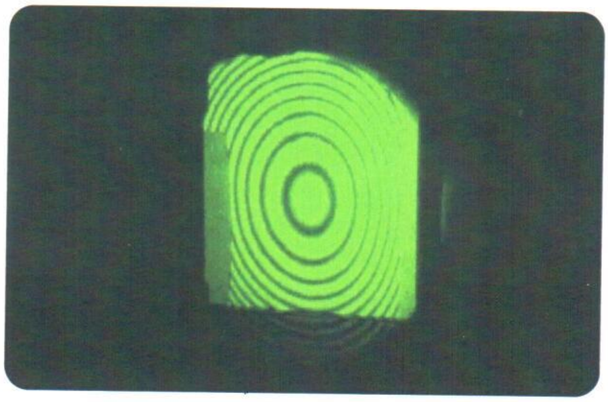
Calibrating the micrometer :

For more accurate measurements of the mirror movement, you can use a green (532nm) laser to calibrate the micrometer.



Insert the laser in to the laser module. Switch on the power supply.

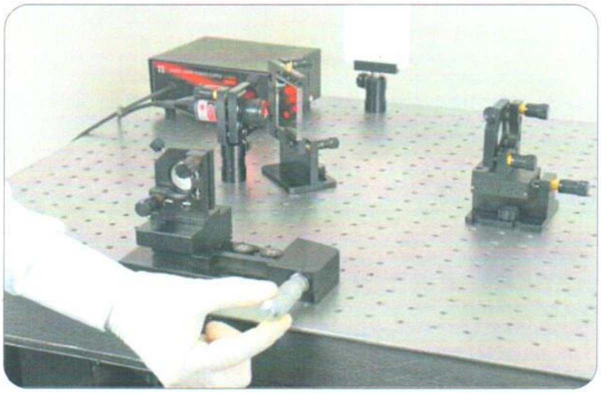


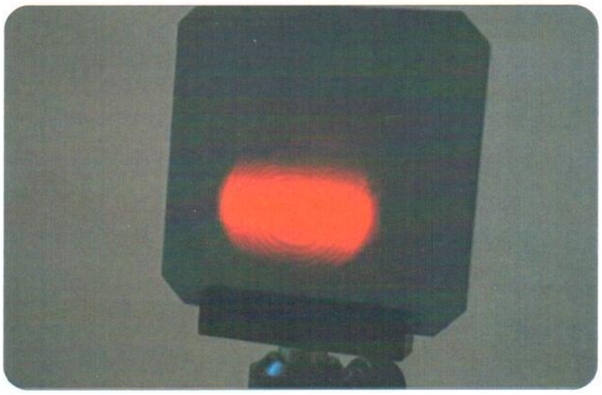


Turn the micrometer knob as you count off at least 20 fringes. Carefully note the change in the micrometer reading and record this value as **d'**. The actual mirror movement $d = N \lambda / 2$, where λ is the known wave length of the laser and **N** is the number of fringes that were counted. $\Delta = d / d'$ is the calibration constant for the micrometer.

Determination of wavelength of laser beam :

For finding the wavelength of laser source , we are using Red doide laser. Set the interferometer with red laser. Note the initial position of the micrometer.





Turn the micrometer knob as you count off at least 20 fringes. Carefully note the change in the micrometer reading and record this value as **d**.

The wavelength of laser is calculated by:

$$\lambda = (2d / N)\,\Delta$$

where '**d**' is the change in position that occurs for '**N**' fringes to pass and '**Δ**' is the calibration constant of the micrometer as we found in early experiment.

Measurements

Calibration Constant for the micrometer Δ = ...

Least count of the micrometer = ...

Trial No	Fringes Moved (N)	Micrometer reading		Distance Moved (d) mm	Wavelength $\lambda = (2d / N)\Delta$ nm
		Initial	Final		
1.					
2.					
3.					
4.					
5.					

Average wavelength λ = ...nm

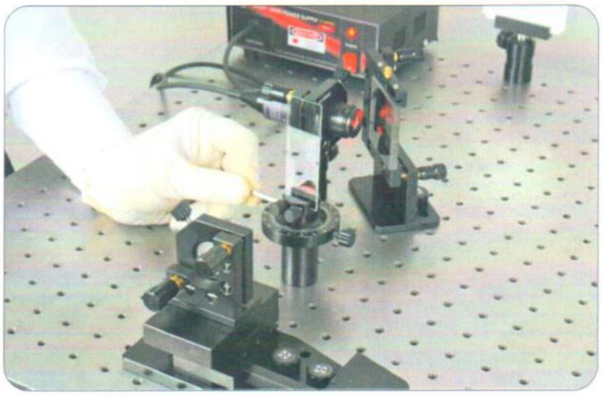
Result :-

The wavelength of laser beam λ = ...

:: Refractive Index of Transparent material

Theory :

The light passes through a greater length of glass as the plate is rotated. The change in the path length of the light beam as the glass plate is rotated and relates the change in path length with the laser beam through air.



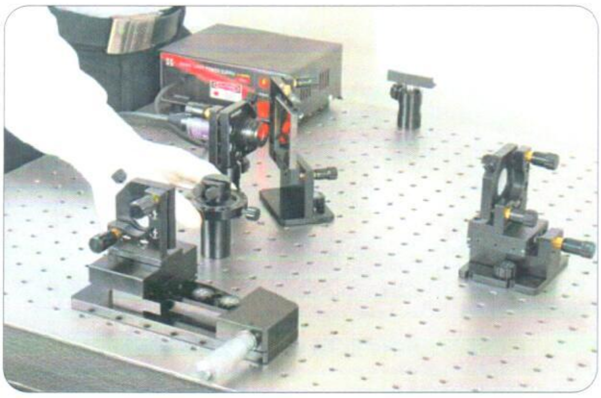
The refractive index of glass slide,

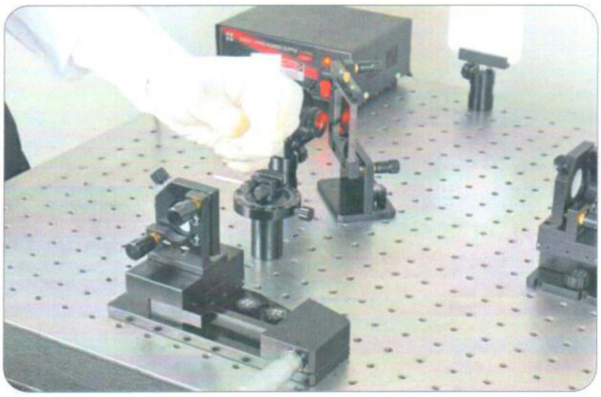
$$n = \frac{(2t - N\lambda)(1 - \cos\theta)}{2t(1 - \cos\theta) - N\lambda}$$

where **t** is the thickness of the glass slide, **N** is the number of fringes counted, λ is the wave length of light used and θ is the angle turned for **N** fringes.

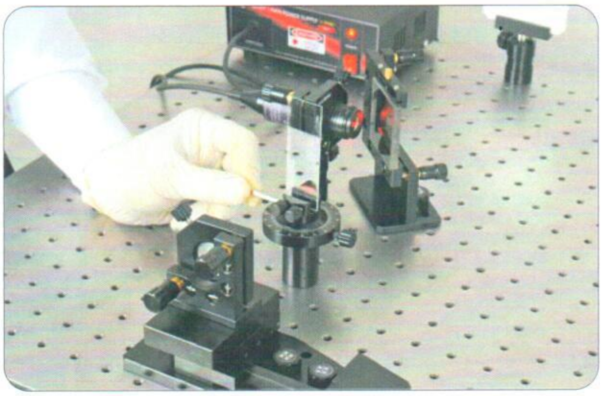
Procedure :

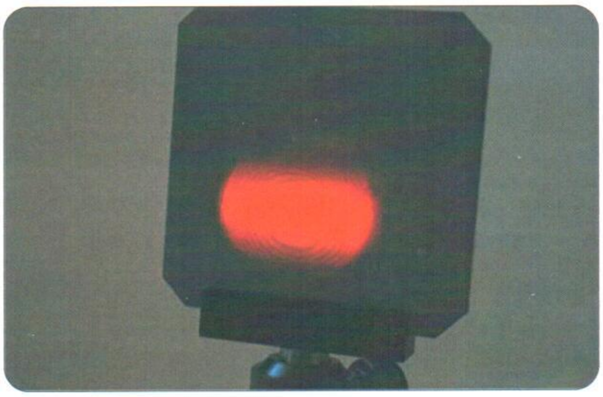
Place the glass slide holder in one of the arms of the interferometer. Attach the glass slide to the rotation stage and make it perpendicular to the laser beam.





Note: *When glass plate is introduced in the optical path of Michelson interferometer, the fringe will be shifted & will become blur. To make the fringe sharp again, move mirror with translation to & fro till the clear set of fringes is achieved on the viewing screen.*





Note the initial position of the glass slide from the dial. Rotate slowly by counting the number of fringes passing. Note the final reading.

The difference is the angle of rotation θ

$$n = \frac{(2t - N\lambda)(1 - \cos\theta)}{2t(1 - \cos\theta) - N\lambda}$$

Measurements

Least count of the rotation stage = ...

Trial No	Fringes Moved (N)	Angle rotated		Mean θ	Refractive index n
		Left	Right		

Result :-

Refractive index of Glass Slide n = ...

Refractive Index of Air

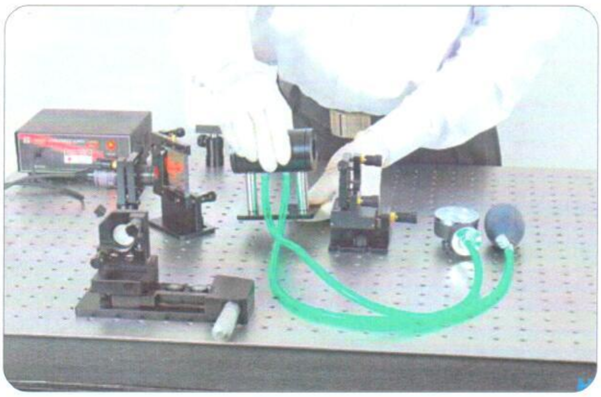
Theory :

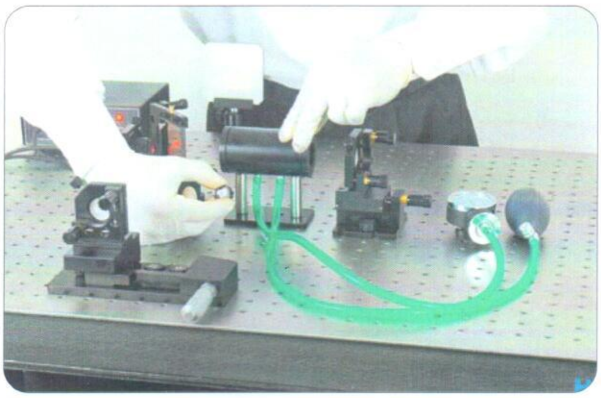
When a piece of material of thickness d is placed in one arm of the Michelson Interferometer, the change in optical path length is given by 2dn where n is the difference in refractive index between the sample and the material it replaced (usually air). In other words, $2d\,(n_m - n_{air})\,/\,\lambda$ extra wavelengths are introduced if air is replaced by a sample of refractive index n_m.

Let λ be the wavelength of light, n the refractive index of air at atmospheric pressure, d the length of the air cell, P_{atm} the current atmospheric pressure and ΔP the pressure change. The relationship between the pressure change ΔP and the number of fringe shift $m_{\Delta P}$ is given by,

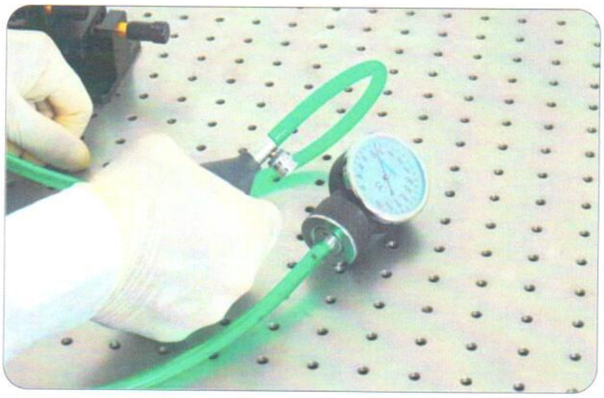
$$m_{\Delta P} = (2d\,(n-1)\,/\,\lambda)\,(\Delta P / P_{atm})$$

Procedure :



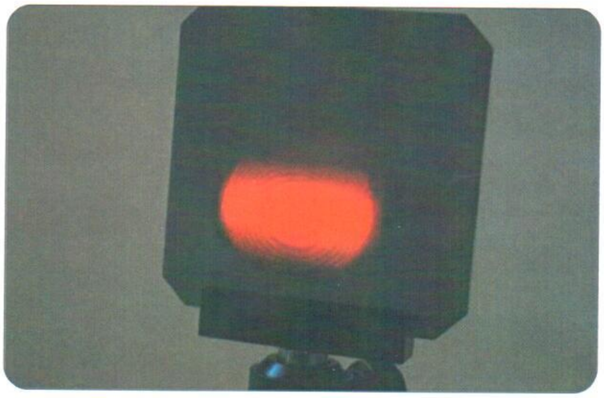


For finding the refractive index of air, we are placing air chamber in one of the arms of the interferometer. Fix it with thumb screws.



Tight the knob of the pump. Pressurize it up to 300 mm Hg.

Caution: Do not increase the pressure beyond 300mm Hg since this may damage the manometer.



Slowly release the pressure and count the number of fringes passing. Reading of manometer can be tabulated up to the total release of air from the chamber.

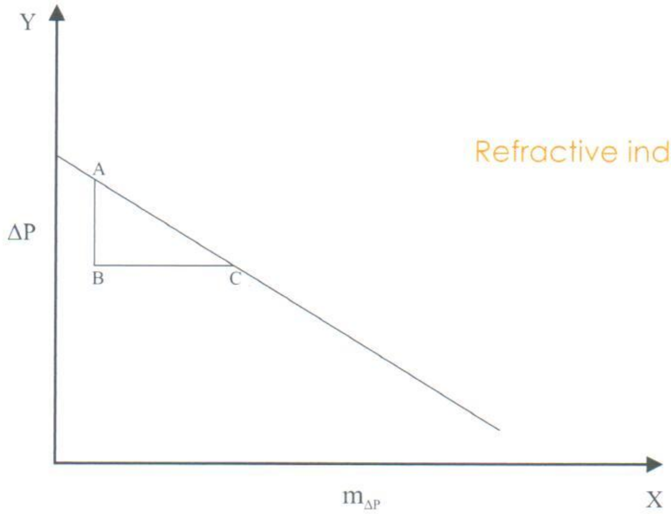
Plot a graph between number of fringes and the corresponding pressure. The slope of the graph will give the value $m_{\Delta P}/\Delta P$. Put this value in the equation given below.

$$m_{\Delta P} = (2d\,(n-1) / \lambda)\,(\,\Delta P / P_{atm})$$

From the above equation, we can calculate the value of refractive index of air '**n**'.

Measurements

Number of Fringes Counted $m_{\Delta P}$	Pressure in the Cell ΔP (mm Hg)



Refractive index of air

We have,

$(m_{\Delta P} / \Delta P) = (2d\,(n-1)/\lambda)\,(1/P_{atm})$

Length of the pressure cell d =

Wavelength of light used =

$m_{\Delta P} / \Delta P$ from graph =

$$\mathbf{(n-1) = (m_{\Delta P} / \Delta P)\ (\lambda / 2d)\ P_{atm}}$$

Substituting the values we can calculate refractive index of air.

Result:-

Refractive index of air n = ...