6. Repeat the steps 4 and 5 several times, tabulate the observed data in Table 2. Finally, obtain an averaged value of the change in optical path with the translation of the biprism and determine the base-angle using the formula given in the table.

Observations

Table 1

Determination of wavelength of the laser source

Least count of the micrometer screw = 0.01 mm.

Number of fringes collapsed/ appeared (m)	Micrometer Position						$\|b - a\| = d_1$ (mm)	$d = d_1/10$ (mm)	Wavelength ($\lambda = 2d / m$) (nm)
	Initial			Final					
	MSR	CSR	Total (a) (mm)	MSR	CSR	Total (b) (mm)			
52	10	17	10.17	9.5	49	9.99	0.18	0.018	692.31
54	9.5	46	9.96	10	14	10.14	0.18	0.018	666.67
55	10	30	10.30	10	12	10.12	0.18	0.018	654.54
53	10.5	49	10.99	10.5	31	10.81	0.18	0.018	679.25
56	10.5	32	10.82	11	0	11.00	0.18	0.018	642.86

Important note: The distance travelled by the mirror must be read off on the micrometer screw and divided by ten (lever reduction 1:10).

−0.5

4

Table 2

Determination of the base-angle of the Fresnel's biprism

Wavelength of laser source (λ) = 667.13 nm

Refractive index of the material of the Fresnel's biprism (n) = 1.48

Least count of the translation stage = 0.01 mm

Number of fringes collapsed/ appeared (m)	Translation stage Position						$\|b - a\| = l$ (cm)	$t = \frac{m\lambda}{2(n-1)}$ (μm)	$\phi = \frac{t}{l}$
	Initial			Final					
	MSR	VSR	Total (a) (cm)	MSR	VSR	Total (b) (cm)			
52	12	18	12.018	11.8	46	11.846	0.172	36.14	0.021
54	11.75	34	11.784	11.55	48	11.598	0.186	37.53	0.020
55	11.6	8	11.608	11.4	28	11.428	0.180	38.22	0.021
53	11.45	21	11.471	11.25	41	11.291	0.180	36.83	0.020
56	11.7	22	11.722	11.5	46	11.546	0.176	38.91	0.022

14/1/19

Results

The averaged value of the wavelength of the laser source obtained from Table 1 is 667.13 nm.

+10

The averaged value of the base-angle of the Fresnel's biprism obtained from Table 2 is 0.021

+09

-0.5

Error calculations

(i) The wavelength of the laser source is given by: $\lambda = \frac{2d}{m}$

Find: $\frac{\delta\lambda}{\lambda} = 2\frac{\delta d}{d} + \frac{\delta m}{m}$

The '2' factor that appears with $\frac{\delta d}{d}$ term in the above expression is related to the fact that d is obtained as a difference of two scale readings, each with an error equal to the least count of the instrument.

$$\frac{\delta\lambda}{\lambda} = 2 \times \frac{0.001}{0.018} + \frac{1}{52}$$

-0.5

$$\frac{\delta\lambda}{\lambda} = \frac{61}{468} \Rightarrow \boxed{\frac{\delta\lambda}{\lambda} = 0.13}$$

(ii) The base-angle of the Fresnel's biprism is given by: $\phi = \frac{t}{l}$; $\phi = \frac{m\lambda}{2(n-1)l}$

Find: $\frac{\delta\phi}{\phi} = \frac{\delta m}{m} + \frac{\delta\lambda}{\lambda} + 2\frac{\delta l}{l}$

The '2' factor that appears with $\frac{\delta l}{l}$ term in the above expression is related to the fact that l is obtained as a difference of two scale readings, each with an error equal to the least count of the instrument.

$$\frac{\delta\phi}{\phi} = \frac{\delta m}{m} + \frac{\delta\lambda}{\lambda} + 2 \cdot \frac{\delta l}{l}$$

$$\frac{\delta\phi}{\phi} = \frac{1}{52} + \frac{61}{468} + 2 \times \frac{0.001}{6.172}$$

$$\frac{\delta\phi}{\phi} = \frac{811}{5031} \Rightarrow \boxed{\frac{\delta\phi}{\phi} = 0.161}$$

8.5/10

Precautions

(i) Never look directly into a non attenuated laser beam.

(ii) Align the interferometer very carefully. Do not disturb it once the fringes are obtained.

(iii) The interferometer is very sensitive to vibrations on the table and also on the floor. Avoid touching the table on which the experiment is set-up.

Questions

1. What do you understand by interference of light?
2. What is a coherent light source?
3. What is the role of coherence of the light source in the Michelson interferometer?
4. What would happen if a thin-glass-slide of refractive index 1.55 (at 632.8 nm) and thickness 20 microns is introduced in one of the arms of the Michelson interferometer? Can you make an estimate of the number of fringes that collapse / appear?
5. According to you, what could be the possible applications of studying interferometry?

References

1. Optics by E. Hecht
2. Optics by A. Ghatak
3. PHYWE, LEP 2.2.05, Michelson Interferometer

Ex-10

1. The superposition of two light waves to form a resultant wave of greater, lower or same amplitude

2. Two waves are called coherent if they have a constant phase difference and the same frequency and the same waveform.

3. To obtain stable interference pattern.

4. $\Delta x = (\mu - 1)t$
$= 1.1 \times 10^{-5}$ m

$18 > \frac{\Delta x}{\lambda} = 17.38 > 17$

Thus 17 fringes collapse / appear

5. a) precise maps of surfaces
b) Astronomers use interferometers to combine signals from telescopes.
c) Metrology

Discussion

→ Michelson interferometer uses the principle of superposition of two light waves to produces resultant wave of higher, lower or equal intensity. This produces a circular fringe pattern of bright and dark patches.

→ Through this experiment I came to know about superposition of two coherent light sources to produce circular fringe pattern. I also learnt how Michelson Interferometer could be utilised to determine the wavelength of a light source and to determine base angle of Fresnel biprism.