Michelson Interferometer

PHYS 2202: Wave Motion and Optics

Lab Section A2

Winter 2024

Camila Restrepo

101230443

Carleton University

February 4, 2024

0. Contents

1. Introduction

1.1 Objectives

1.2 Part 1

1.3 Part 2

The lensmaker equation gives us a way to find the focal point of a double lens based on its geomtry. In particular,

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Downarrow$$

$$f = \frac{R_1 R_2}{(R_2 - R_1)(n-1)} \tag{1.1}$$

where R_1, R_2 are the radii of curvature of each side of the lens, and n is the refractive index of the lens' material. Using a spherometer, these radii are found by

$$R = \frac{r^2 + d^2}{2r} \tag{1.2}$$

where r is the spherometer reading, and d is the distance from the leg of the spherometer to the screw. So by simply taking some readings of the lens using the spherometer, we are able to find its focal length.

2. Experimental setup

2.1 Apparatus

The instruments used were as follows:

-

2.2 Procedure

Part 1 Lorem ipsum dolor sit amet

Part 2 Lorem ipsum dolor sit amet

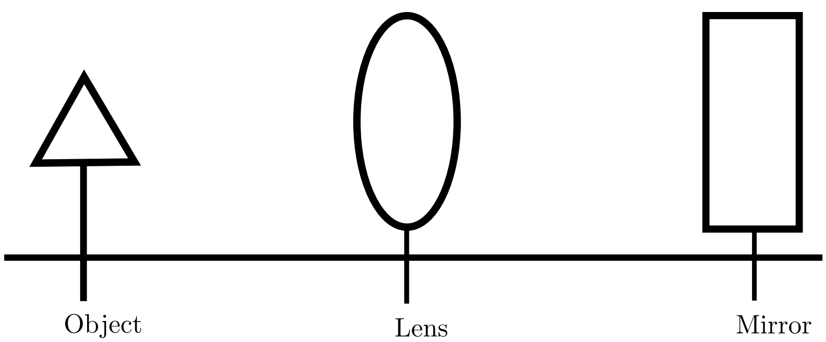

Figure 2.1: Experimental setup for Part 2

3. Observations

Little note here about the observations

3.1 Part 1

Trial	1/s_i	1/s_o	err_i	err_o
1	$2.88 \cdot 10^{-3}$	$2.22 \cdot 10^{-3}$	$1.17 \cdot 10^{-5}$	$6.97 \cdot 10^{-6}$
2	$2.78 \cdot 10^{-3}$	$2.32 \cdot 10^{-3}$	$1.09 \cdot 10^{-5}$	$7.62 \cdot 10^{-6}$
3	$2.64 \cdot 10^{-3}$	$2.43 \cdot 10^{-3}$	$9.85 \cdot 10^{-6}$	$8.35 \cdot 10^{-6}$
4	$2.55 \cdot 10^{-3}$	$2.56 \cdot 10^{-3}$	$9.21 \cdot 10^{-6}$	$9.25 \cdot 10^{-6}$
5	$2.65 \cdot 10^{-3}$	$2.69 \cdot 10^{-3}$	$9.93 \cdot 10^{-6}$	$1.03 \cdot 10^{-5}$
6	$2.29 \cdot 10^{-3}$	$2.85 \cdot 10^{-3}$	$7.41 \cdot 10^{-6}$	$1.14 \cdot 10^{-5}$
7	$2.09 \cdot 10^{-3}$	$3.02 \cdot 10^{-3}$	$6.19 \cdot 10^{-6}$	$1.29 \cdot 10^{-5}$
8	$1.57 \cdot 10^{-3}$	$3.23 \cdot 10^{-3}$	$3.49 \cdot 10^{-6}$	$1.47 \cdot 10^{-5}$
9	$2.96 \cdot 10^{-3}$	$2.09 \cdot 10^{-3}$	$1.24 \cdot 10^{-5}$	$6.15 \cdot 10^{-6}$

Table 3.1: Sample table

4. Data analysis

4.1 Part 1

4.2 Part 2

Trial	$\frac{1}{s_o}[\mathrm{mm}^{-1}]$	$\frac{1}{s_i}[\mathrm{mm}^{-1}]$
1	$2.22 \cdot 10^{-3}$	$2.878 \cdot 10^{-3}$
2	$2.32 \cdot 10^{-3}$	$2.782 \cdot 10^{-3}$
3	$2.43 \cdot 10^{-3}$	$2.639 \cdot 10^{-3}$
4	$2.558 \cdot 10^{-3}$	$2.551 \cdot 10^{-3}$
5	$2.692 \cdot 10^{-3}$	$2.649 \cdot 10^{-3}$
6	$2.845 \cdot 10^{-3}$	$2.288 \cdot 10^{-3}$
7	$3.021 \cdot 10^{-3}$	$2.092 \cdot 10^{-3}$
8	$3.226 \cdot 10^{-3}$	$1.571 \cdot 10^{-3}$
9	$2.086 \cdot 10^{-3}$	$2.963 \cdot 10^{-3}$

Table 4.1: Values to plot in thin lens (plotted) method

We calculate the radius of curvature from the spherometer readings by eq. (1.2)

$$\begin{aligned} R &= \frac{r^2 + d^2}{2r} \\ &= \frac{(1.34\,\mathrm{mm})^2 + (22.5\,\mathrm{mm})^2}{2\,(1.34\,\mathrm{mm})} \\ &= 189.6\,\mathrm{mm} \end{aligned}$$

with error

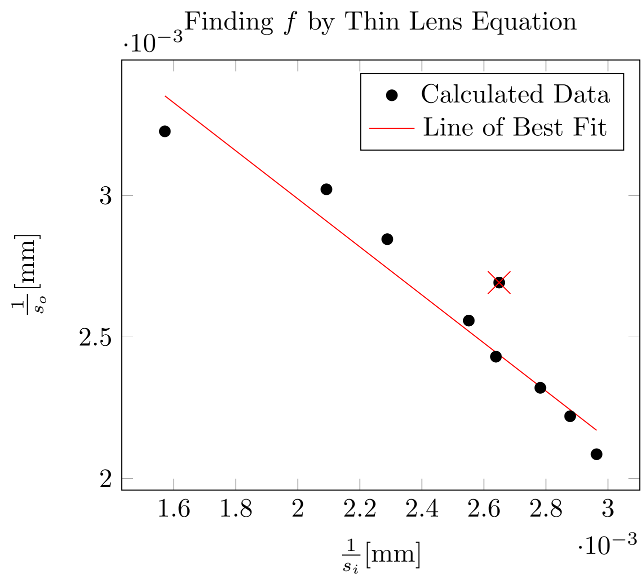

Figure 4.1: Plot of the values from table 4.1

$$
\begin{aligned}
\sigma_R &= \sqrt{\frac{\left(r^2 - d^2\right)^2}{4r^4}\sigma_r^2 + \frac{d^2}{r^2}\sigma_d^2} \\
&= \sqrt{\frac{\left(\left(1.34\,\mathrm{mm}\right)^2 - \left(22.5\,\mathrm{mm}\right)^2\right)^2}{4\left(1.34\,\mathrm{mm}\right)^4}\left(0.025\,\mathrm{mm}\right)^2 + \frac{\left(22.5\,\mathrm{mm}\right)^2}{\left(1.34\,\mathrm{mm}\right)^2}\left(0.707\,\mathrm{mm}\right)^2} \\
&= 12.4\,\mathrm{mm}
\end{aligned}
$$

making sure to respect the sign convention. For our final focal length, we obtain $f_{\mathrm{LNS}} = 187.7\,\mathrm{mm}$, $\sigma_{\mathrm{reading}} = 10\,\mathrm{mm}$, and $\sigma_{\mathrm{st.\ dev.}} = 7.2\,\mathrm{mm}$. Since $\sigma_{\mathrm{st.\ dev.}} \leq 2\sigma_{\mathrm{reading}}$, we take $\sigma_{\mathrm{LNS}} = \sigma_{\mathrm{reading}}$, and obtain

$$f_{\mathrm{LNS}} = (188 \pm 10)\mathrm{mm}.$$

5. Results

6. Discussion