Lab Book – Optical Cavity

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Task List

As usual, we are going to spend the first lab playing around with the equipment.

* Alignment – There was a step by step video for aligning provided on Canvas, we will be following this to align the cavity.
* Mirror reflectivity – We need to determine the reflection and transmission coefficients of the mirrors inside the cavity. We will use the power meter to measure the incident, reflected and transmitted power.

Alignment

Following the video provided on Canvas, we aligned the laser in the following way:

* Remove the first mirror (M1) in the cavity and try and first to align the first two turning mirrors
  + This is done by moving the second mirror (M2) of the cavity along the rail
  + First move M2 far along the rail and adjust the far turning mirror
  + Move M2 closer to the second turning mirror and make fine adjustments with the second turning mirror
  + Move M2 farther back and repeat the tuning process above until convergence
* Place the lens in between the two turning mirrors at an approximate distance of 50cm from M1
  + Make the height is properly aligned for this lens, so we had to repeat a similar process as before
* Next place in M1 and make sure that the reflected light from M1 lays over top of the incident light (look at the first turning mirror)
* Finally align M2 so that the reflected light of M2 overlaps with the transmitted light from M1

// TODO make diagram of setup

Mirror Reflectivity

Procedure:

* First using the aligned system we calculated the incident power after the second turning mirror
* Next we calculated the Transmitted coefficient for M1 and M2 by placing the power meter behind the mirror
  + Note, we made sure to rotate M1 around 180 degrees since we are trying to characterize what is inside the cavity
* We then had to un-align the system to record the reflectivity coefficient for M1 and M2

The following Matlab code contains the data measured using the power meter and calculations of uncertainty for R, T for both mirrors.

%% Mirror Reflectivity

%Incident Power $= 6.63 \pm .015 $mW (Note: loss due to alignment mirror,

%so did after mirror)

P\_I = 6.63e-3; %W

% M1 Transmitted Power = 82.5 \pm 1.5 \mu W

% P\_M1\_trans = 82.5e-6; %W

% % M1 Relected Power = 5.93 \pm .05 $mW

% P\_M1\_ref = 5.93e-3; %W

% ^above measurements use wrong side of mirror (not shiny side)

% ------------ %

% FIRST MIRROR %

% ------------ %

% M1 Transmitted Power = 77 \pm 1 \mu W

P\_M1\_trans = 77.5e-6; %W

% M1 Relected Power = 6.43 \pm .05 $mW

P\_M1\_ref = 6.43e-3; %W

% Reflection coefficient

R\_M1 = P\_M1\_ref/P\_I

delta\_R\_M1 = (0.05e-3 / P\_M1\_ref + 0.015e-3 / P\_I) \* R\_M1

% Transmission Coefficient

T\_M1 = P\_M1\_trans/P\_I

delta\_T\_M1 = (1e-6 / P\_M1\_trans + 0.015e-3 / P\_I) \* T\_M1

%Should add to 1

T\_M1 + R\_M1

% ------------- %

% SECOND MIRROR %

% ------------- %

% M2 Transmitted Power = 124 \pm 1 \mu W

P\_M2\_trans = 124e-6; %W

% M2 Reflected Power = 6.35 \pm .01 mW

P\_M2\_ref = 6.35e-3; %W

% Reflection coefficient

R\_M2 = P\_M2\_ref/P\_I

delta\_R\_M2 = (0.01e-3 / P\_M2\_ref + 0.015e-3 / P\_I) \* R\_M2

% Transmission Coefficient

T\_M2 = P\_M2\_trans/P\_I

delta\_T\_M1 = (1e-6 / P\_M2\_trans + 0.015e-3 / P\_I) \* T\_M2

% Should add to 1

T\_M2 + R\_M2

|  |  |  |
| --- | --- | --- |
|  | Mirror 1 | Mirror 2 |
| R |  |  |
| T |  |  |
| R + T |  |  |

Q: Do your reflectivity and transmission coefficients add to 1? Should they?

Our values do not add to one. This occurs because the mirrors are not ideal and there is some loss due to absorption. The coefficients are also angle dependent so this may also account for some loss. Overall, our values are pretty close to 1 which should be good enough for this lab.

Q: Calculate the Finesse that you expect the cavity to have.

A quick calculation gives us a value of F = 85.1560

Q:

**MON MAR 19, 2018**

Everything sucked and nothing worked

* Talk about the fringes we were finding and

**MON MAR 26, 2018**

Task List

This lab we need to record data to calculate the finesse of the optical cavity as we think this is the most important part of the lab.

* Retrieve data for the FWHM of three different cavity lengths
  + At small distances (1 cm)
  + Medium distances (10-15cm)
  + Large distances (close to edge of stability)

Cavity Observations

Finesse

Most data taken at 62V

Last one taken at 75V