

# MAS450 Lab #1:

## Michelson Interferometer and lab introduction

### Introduction

The constructive and destructive overlap of light waves to form "interference fringes" is the central mechanism of holographic recording. This laboratory will explore interference in two contexts: coarse fringes in the Michelson interferometer, and moderately fine fringes in an overlapping-beam experiment that mimics holographic recording. In both cases, you will observe (and in the second, record) high contrast fringes formed in laser light, and thus you will also be introduced to laser operation and optical hardware, and the related safety issues.

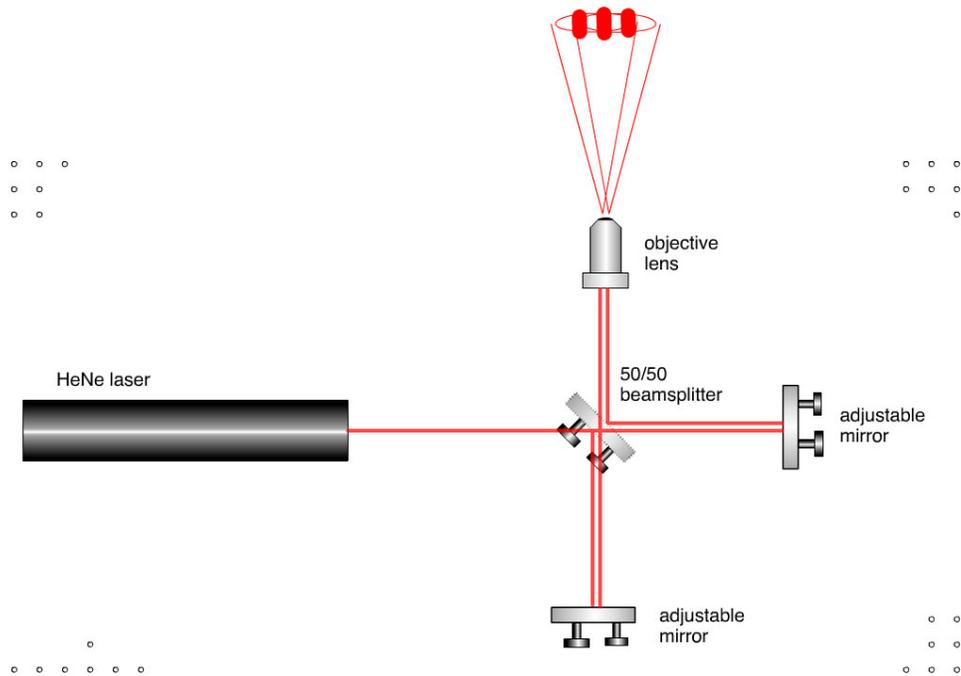
These notes will describe the experiments involved with only a little background, and a few comments on specific setups. They will also request that you make some observations, and occasionally remark on the results. You should enter these responses into your laboratory notebook—the teaching staff will review them during the term. Entries should include raw data as well as sketches, and it is best to do as much notebook work as possible while still in the lab. If you clean up your data later, do not obliterate the original entries! Remember, it must be possible for someone else to understand and repeat all of your experiments from your notebook entries, to understand what you saw, and the conclusions you drew. We intend the labs to be as open-ended as possible, and to gently suggest further topics for you to study. You should also enter these ideas in your notebook.

### Laser Safety

If this is your first experience with a laser, you probably have a few questions about its safest use. We are using a low-power helium-neon continuous-wave gas laser. The output power is only a few milliwatts, not enough to damage your eyes if you are careful **not to look down the undiverged beam**, or any reflection of it by a shiny surface. Review the Laser Safety Guide pamphlet in the lab, and ask your Teaching Assistant if you have any questions about safe use of these lasers. Lab safety will be reviewed in lecture.

### The Michelson Interferometer

Invented by A.A. Michelson in 1881 to study theories of the aether, this simple and robust optical design is now finding a new life as a diagnostic tool for holography tables, and here as an interference demonstration. The setup is roughly as shown on the accompanying sketch, although it can be tricky to align. If you take care to keep the beams parallel to the table top, and to adjust each mirror to return the laser beam to the spot where it first passes through the beamsplitter, you should find good fringes with only minor twiddling.



## Procedure

- 1) Set up the interferometer with mirror legs of roughly equal length, perhaps 150 mm (6 inches). Successful alignment requires keeping the beams at a uniform height above the table surface; this should be 200 mm (8 inches) for these labs.
- 2) Adjust the mirrors to give broad (perhaps 10 mm wide) vertical fringes on the screen. Note the sensitivity of the fringe pattern to disturbances on the table, especially nudges to the components, warm air drafts in either leg, stresses on the table (which should not be floating for this lab), and so forth. Try to arrange things so that the entire screen is as dark as possible. The screen will light up when you block either beam, but is dark when both legs are open! Discuss where the energy has gone.
- 3) Increase the length of one of the legs by 100 or 150 mm and observe any change of the contrast of the interference fringes. Interpret this and find the approximate "coherence length" of the laser you are using.
- 4) Further increase the length of one of the legs until it is one laser cavity length longer than the other leg; observe the interference fringe contrast, and discuss the results. The interferometer is much more sensitive with longer legs, and can be used to judge the stability of the table, the vibration state of the room, the maximum practical exposure time, and other useful factors. Comment on a few of these effects in your notes.

## The Coffeecup hologram demo revisited

In the in-class coffeecup demonstration, you saw a common holographic setup and a hologram made with it. In this lab, you will see the steps of the hologram-making process you didn't see in that demonstration, including calculating exposure time, exposing the plate, and processing it.

Your TA will do most of the actual work for this part of the lab; you should use this time to learn about the lab, to document the setup and process, and to ask questions. By about halfway through the term, you'll build apparatus like this one yourselves.