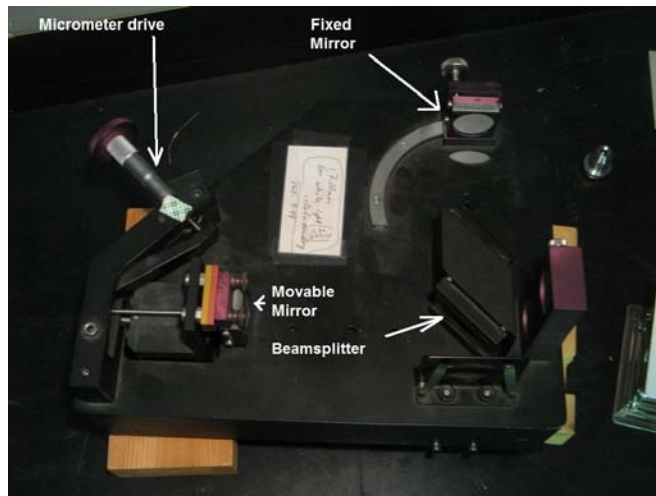


THE MICHELSON INTERFEROMETER

BACKGROUND RESEARCH

Read about the Michelson-Morley experiment. Find an equation that relates the [classically] predicted phase shift to the parameters of the interferometer. A good place to start to look for this information would be your textbook and other textbooks. I will expect you to do this step in the future before the week's lab.



EXPERIMENT #1: THE MICHELSON-MORLEY EXPERIMENT

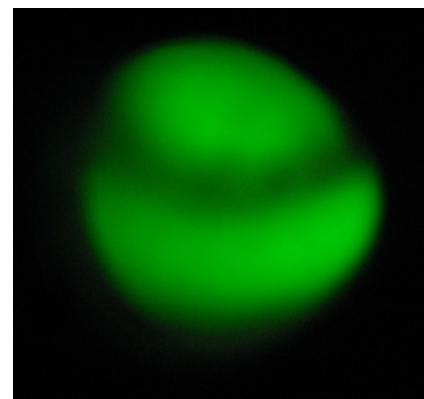
Use the data from your literature search, plus make measurements of our Michelson Interferometer, to calculate the expected, classical fringe shift that would result from using 550nm (green) light and this interferometer to measure (a) the daily rotation of the Earth about its axis (remember, you are at the 45th parallel, not the equator) and (b) the yearly motion of the Earth around the Sun. Now, given that you would need a precision equal to about a third of either value to be able to discard the classical value, calculate what number of fringe shifts you need to be able to discern to use this interferometer for the M-M experiment.

The instructor will show you another (larger) interferometer in the department that can be configured as a Michelson interferometer. Repeat the calculations above. If warranted, set up one or the other interferometer on a turntable and recreate the Michelson-Morley experiment.

EXPERIMENT #2: THE WHITE-LIGHT MICHELSON INTERFERENCE PATTERN

STEP 1: ALIGN THE TWO MICHELSON INTERFEROMETER IMAGES

- Mount a green Helium Lamp as the source.
- Adjust the two set screws on the back of the one mirror (the one that has two set screws on it) to align the reflections coming from the two separate mirrors. When they are close to exact alignment, you will start to see "pinstripes" in the green field of view. Adjust the set screws very gently and slowly!
- Adjust the set screws until these stripes become wider. Keep going. If you're lucky you may be able to turn these stripes into the center of a bull's eye pattern (with the concentric circles getting closer as you move away from the center. Adjust the stripe/circles as best as you can to get the center of the bull's eye.
- Sketch and describe what you see in your lab notebook.

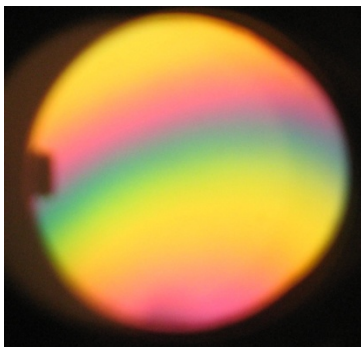


STEP 2: CHANGING THE PATH LENGTH

- You should be able to get constructive interference (which will show up as a bright spot in the middle of the bull's eye center) if the two path lengths in the interferometer are either equal, or differ by an integer number of HALF-wavelengths. Adjust the single set screw on the other mirror to move that mirror straight in or out. Describe in your lab notebook what happens to your interference pattern – both at its center and away from the center (the pinstripes).

STEP 3: APPROACHING THE WHITE-LIGHT INTERFERENCE PATTERN

- If the path lengths are much different, the center of the bull's eye will shrink: the center dot in the bullseye will get smaller.
- Dial this second mirror forward and backward and verify that at the extremes this pattern does shrink.
- Now dial the adjustable mirror until the vernier along its side reads about 17mm. The path lengths should now be close to equal.
- Replace the green light source with a white light bulb. Shield your eyes from the lightbulb's direct light so that you can still see the bull's eye clearly.



- SLOWLY adjust the knob (on the mirror with just one knob) in search of something interesting. It is probably somewhere between 16mm and 18mm. When something interesting happens to the white screen, slow down even further and describe in your notebook what happens if you continue in that direction. Repeat this for the bull's eye center and for some "pinstripes" not too far away from the center.
 - Sketch the pattern near this magical location in your notebooks and describe it thoroughly. Record what the mirror's knob's vernier records for the middle of this magical zone.
 - Dial in the bullseye center again and replace the white light source with the green helium lamp. Describe what you see and describe what differences, if any, there are between this bulls eye pattern and the one when the path lengths aren't quite equal.
- Explain why the two should behave differently.

EXPERIMENT #3: WAVELENGTH MEASUREMENT WITH THE MICHELSON INTERFEROMETER

- Mount the green helium light source. Make sure the interferometer is set up to display interference fringes. You can use either the central bullseye or a set of moderately wide fringe stripes.
- Dial the movable mirror to a round number, like 17.00mm, on its vernier (Record this value in your notebook). Keeping your eye glued on the location of one of the fringes (or the bullseye) and resting your chin on the lab table or on your hand on top of the lab table (so that your head doesn't move), slowly turn the set screw until 100 fringes glide by (or the bullseye goes from bright to dark to bright again 100 times). Record the final mirror position in your notebook. This distance represents the length of 100 half wavelengths. Sort of.
- You will notice that the vernier screw does not directly drive the mirror holder, but is levered. Verify that the vernier only moves the mirror 4mm when it's been dialed 20mm. Use this fact to properly calibrate the calculation you did above for the length of 100 half wavelengths (which equals *how many* full wavelengths?). Calculate and record the wavelength of the green line in the mercury spectrum. Look up the accepted value for this wavelength.
- Repeat the data taking (the length of 100 half wavelengths) several times, and have your partner do the same. What is your best value and its uncertainty? This uncertainty is very important for comparing your values to the accepted value.