Lab #7 -- Fizeau Interferometer

The purpose of this lab is to observe Fizeau fringes, multiple beam fringes, and learn how to use test plates. We will also test the resolving power of a Fabry-Perot etalon.

Preparation:

Review Newton's rings and Fizeau fringes. Determine how to tell whether the test surface is concave or convex. See Hecht and Zajac Chapter 9, and Chapter 1 of Malacara "Optical Shop Testing". Review attached notes. See Francon, "Optical Interferometry," pp. 115-118.

Obtaining Fizeau Fringes:

1) Clean the surfaces using methanol and lens tissue. The lab instructor will show you the proper procedure.

2) Place a piece of lens tissue on the bottom surface, place the other surface on top, and then pull out the tissue. You should see about 10 or fewer fringes. If more are present, make sure the surfaces are clean and try again.

3) If you press on the edge of the top piece using a pencil eraser, you will see the fringes move. Be sure not to poke at the optics with sharp objects which might scratch the surfaces.

4) To separate the surfaces, carefully lift off the top surface. Do not drag it across the bottom surface. This will cause scratches.

Tasks:

Observe fringes using the curved test plates, two uncoated flats, two coated flats, and one coated with one uncoated flat. For each test:

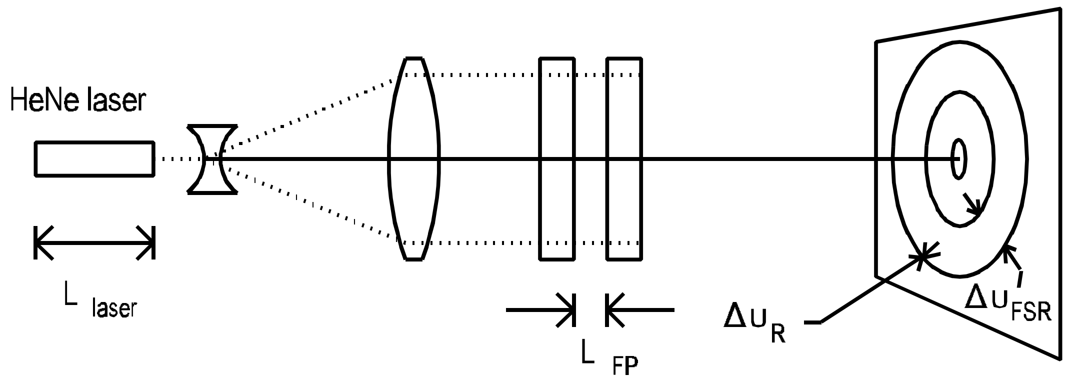
1) Sketch the resulting interference fringes.

2) Estimate surface irregularities.

3) Calculate radius of curvature of curved surfaces.

4) Determine whether surfaces are concave or convex. If the fringes are not curved, determine whether you have a bump or a hole causing fringe irregularities.

Fabry-Perot:



Using the laser supplied by your lab TA, adjust the plane Fabry-Perot interferometer to small (~ 3 mm) plate separation. By viewing the ring pattern:

1. What resolution is obtained? (Use known c/2L as scale factor.)

2. Estimate the finesse obtained. Is this sufficient to resolve this laser's longitudinal modes?

3. If your plates were perfectly flat and diffraction loss negligible, what reflectivity would be impled by the finesse you have measured? (Assume $R_1 = R_2$)

4. How flat should the plates be? Recall that finesse = $\pi\sqrt{R}/1(1-R)$. Is this flatness reasonable?

5. Now pull the plates apart to obtain the best possible resolution in order to resolve the laser modes. Can you resolve the laser's longitudinal modes?

6. Is the observed finesse at large separation as good as that for L = 3 mm? The variable is diffraction loss, which will be smallest if you use most of the available plate area. However, then figure imperfections become more serious.

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Questions:

1) What differences do you notice in fringes obtained using coated surfaces from those using uncoated surfaces?

2) Do multiple beam fringes give you more information than normal sinusoidal fringes?

3) How accurately can you determine the quality of the test piece?

4) How important is the quality of the reference surface?

5) How would you determine the quality of the reference surface?

6) Design a plane-parallel Fabry-Perot cavity to measure characteristics of laser diodes. Assume the laser diode has a cavity length of 250 μm, $n = 3.6$, $\lambda = 780$ nm, and there are up to ten modes. Assume that each mode is about the same width that you calculated in Lab #7.