Opti 380A – Intermediate Optics Lab I – Fall 2009

Post-Lab Questions for Lab 10: Michelson Applications

Post-lab questions are due at the beginning of lecture on the Monday following your lab.

An interesting application of this experiment would be to measure, interferometrically, the height of Mt. Lemmon. This would work just like we did the experiment in the lab— a decrease in pressure in going from the city to the top of the mountain would change the OPD inside the gas cell and create a fringe movement. In concept, one could seal off the gas cell in the lab, then haul the Michelson up to the top of the mountain, counting the number of fringes that passed by.

In practice, the inverse of this might actually be quite easy to do. Simply take the gas cell up to the top of the mountain (the ski lodge might be nice, especially at lunch time), open it up to the mountain air, and then seal it off. Bring it down to the lab, place it in the interferometer, and slowly open it to the lab atmosphere, counting the number of fringes that move across the field of view. Of course, miscounting the fringes might mean another trip up to the ski lodge!

Let's work the problem in reverse, to see if counting fringes with our gas cell is an accurate way to measure altitude. This is always a good starting point in setting up an experiment-will your equipment and technique allow you to achieve sufficient accuracy in the result you're trying to measure? In our example, will the length D of our gas cell allow us to count enough fringes to make an accurate measurement of the height of Mt. Lemmon?

Assume that we leave campus (elevation 2500 feet) and drive to the Mt. Lemmon Observatory (elevation 9157 feet). Use the following data (taken from the Infrared Handbook) to know how atmospheric pressure varies with altitude:

Height Above Sea Level (km)	Pressure (millibar mb)
0	1013
1	902
2	802
3	710
4	628
5	554

1.) Use your experimental data and equation 10-15 to calculate the number of fringes you expect to see move past your field of view in the output of the interferometer in doing this experiment. Quote your answer to a tenth of a fringe. (For simplicity, assume a linear

fit between the two appropriate pressures when doing your calculations.)

2) What is the estimated error in your answer? Quote your answer in feet. Assume that you can measure the location of a fringe to 0.1 of its width, and assume your error in measuring the length D of the gas cell is 5%.

3) A modern-day GPS receiver can measure altitude to within ±75 feet. What would the length D of the gas cell need to be in order to achieve this uncertainty in measuring the height of Mt. Lemmon?