INTERFERENCE AND DIFFRACTION

Objectives: • To investigate interference and diffraction phenomena using a laser and a collection of narrow slits.
• To use interference effects to measure the wavelength of the laser light.

To Do Before Lab: • Read this lab

Apparatus:
laser (source of monochromatic, coherent light), glass slide with assorted slit patterns, magnifying glass, jackstand, compact disc, retort stand with clamp, washer and tape, mounted meter stick, tape measure, two meter ruler, 30cm ruler

Part I: The Slits
(1) Using the short focal length converging lens as a magnifying glass, examine the collection of slits enclosed in the glass plate. Try to avoid getting fingerprints on the glass. In the lab you can find a sheet that describes the widths, spacings, and number slits on the slit plate. The slit spacings (in mm) are listed below the slits.

(2) Place the slit plate in the clamp. Use the laser to illuminate each of the four **double** slits found in one of the columns. Make a sketch of the interference pattern produced on the screen by each double slit, and describe how the pattern is affected by the spacing of the slits. If you don't get a "clean" pattern for a particular double slit, try moving the laser slightly, since sometimes a slit may have a small defect somewhere along its length.

(3) Examine the pattern produced by each of the **single** slits in the column containing slits of different widths. Make a careful sketch of one of the patterns and describe how the pattern changes as the width of the slit changes.

(4) One of the columns of slits has **multiple** slit apertures including one, two, three, four, and 10-slit apertures with a constant slit spacing. Closely examine the interference pattern produced by the two, three, four, and ten slit apertures. Carefully sketch the patterns for three, four and 10 slits. How does the pattern change as the number of slits increases while the slit spacing remains constant?

Part II: Young's Double Slit Experiment
In this part of the lab you will repeat the famous experiments done by Thomas Young in 1801 that established that light was a wave, and determined its wavelength.

(1) Choose your favorite double slit and make the measurements needed to determine the wavelength of the laser light. Calculate the wavelength of the laser. Estimate the uncertainty of each of your measurements and determine the resulting uncertainty in the wavelength.
(2) If light was a bunch of little particles, what would you expect to see on the screen?

Part III: Using interference and diffraction

In part II of this lab you obtained a fairly accurate measurement of the wavelength of your laser. Now you can use the laser light as a tool and use the interference pattern it produces to measure dimensions of objects that would be very difficult to measure using conventional methods. One important practical application of this technique is the use of x-ray interference patterns to determine the spacing of atoms in a crystal. This is how the structure of many proteins has been determined.

A compact disc (CD) consists of a series of millions of "pits" arranged in a spiral. In this part of the lab you will determine the spacing between the spiral lines. Place the CD in the clamp and shine the laser at it. Place the mounted ruler behind, but near the laser, at roughly the same height as the laser. Adjust the position of the CD so that the reflected interference pattern is visible on the ruler. Be sure the disc is approximately perpendicular to the laser beam by checking that the reflected central maximum hits the laser near where the beam emerges from the laser. Make measurements of the pattern produced and determine the spacing of the grooves.

How thick is your hair?

Mount a strand of hair tautly across the CD with tape. Place the hair in the laser beam. Sketch the diffraction pattern and measure the positions of several of the intensity minima. The patterns created by obstacles are identical to those created by slits of the same shape, in any direction other than the straight through direction. Use this idea and your knowledge of single slit diffraction to find the thickness of the hair. I am most interested in the your explanation of the method.