PHYS 2225 **Interference and Diffraction** **Name:**______________________

Object: To analyze a two-slit interference pattern, a multiple-slit inteference pattern, a one-slit diffraction pattern, and a two-dimensional diffraction pattern.

Theory: Whether light is a wave or particles was one of the great debates in the history of physics, dating back to Huygens (waves) and Newton (particles). One experiment that convincingly showed the wave nature of light was the two-slit interference experiment performed by Thomas Young.

If instead of just two slits we use a grating consisting of a very large number of extremely narrow slits separated by very small distances, we can obtain an interference pattern in which the lines corresponding to different orders are distinctly spaced. Modern optical spectrometers generally use diffraction gratings rather than prisms to obtain spectra of light with many wavelengths present.

For a single slit of width a we also observe a diffraction pattern of alternating light and dark spots or bands because light from one part of the slit interferes with light from another part of the slit.

Safety Considerations: ***Never*** intentionally shine a laser in anyone's eye, and take precautions that the beam doesn't go in yours either. Please handle the slit patterns carefully as they are fragile.

Apparatus: Draw a detailed diagram of the equipment set-up and label the pertinentent dimensions.

Procedure:

1. Double Slit: Carefully design (this can be done before lab) and carry out an experiment to measure the wavelength of a laser using pairs of slits. It should involve varying various variables and making a straight-line graph whose slope is λ. Clearly state your assumptions and verify that they are valid. Compare the slope with the accepted value of λ on the laser.

2. Grating: Using the value of λ just obtained, design and carry out an experiment to measure the line density n of a diffraction grating and compare with the value stated on the grating.

3. Single slit: Use different colored lasers to get data for a graph of w vs. $2\lambda L$ and compare 1/slope with the given value of a. If time permits, repeat with a different slit width.

4. 2-D pattern: Make enough measurements to boost your confidence that you understand the dimensions on the instruction sheets for the 2-D patterns. Comment on your observations.

Questions:

1. How much do the simplifying approximations contribute to your error?

2. In this lab you observed both interference and diffraction. What is the difference?

3. In the two-slit experiment, what two properties of laser light obviate the need for a prior single slit from which the light then impinges on the double slit? Elucidate.

4. In crystals, atoms are arranged in periodic structures that can be thought of as diffraction gratings with a very large line density. What type of electromagnetic radiation should be used to determine interatomic distances and crystal structure? Why? (Hint: see Section 25.2 in Knight.) (The structure of DNA was discovered this way; you may want to read *The Double Helix* by James D. Watson.)

Conclusions: The instructions this week were less specific than in prior labs; this allows you to explore and design your own procedures. Did you enjoy this? Did you learn more than if the printed procedures had been very specific? What did you learn about designing an experiment to measure a specific quantity (such as λ for a laser)?