# INTERFERENCE AND DIFFRACTION

**Objectives:** • To investigate multiple-slit interference and diffraction

### **Apparatus:**

laser (a source of monochromatic, <u>coherent</u> light), single/double slit wheels, pasco optics bench

## <u>Prelab</u>

- 1. Read the sections in you physics text book on single slit interference and Young's double slit interference.
- 2. In lab, you will be measuring distances between the bright constructive interference spots on a screen.



a. Label the m value for each peak in the diagram.

- b. Consider two techniques for measuring the distance between the central maxima and a bright peak. Technique A measure the distance between the left and right peaks and divides by and 2, whereas technique B measures the distance between the central peak and the right peak directly. Which technique will provide a more precise value? Why?
- c. Using the equation for double slit constructive interference (d sinθ = mλ), the small angle approximation, and the diagram below, derive an expression for the distance between the central peak and a given maxima in terms of L, m, λ, and d. L is the distance to the screen, d is the distance between slits, and y is the distance from the central maxima to a given maxima.



### **Part I: Qualitative Observations**

- a) Use the laser to illuminate for favorite 3 of the single slits on the single slit wheel. If you don't get a "clean" pattern for a particular slit, turn the horizontal and vertical adjust knobs to adjust the laser slightly. Make a sketch of each single slit diffraction pattern and label each with the slit width. Place the sketches one beneath the other, properly aligned with each other for clarity. From your sketches it should be clear how the pattern is affected by the slit width.
- b) The multiple slit wheel contains a single slit and double slit comparison opening labeled ii with: <sup>1</sup>. These slits all have the same slit width. Make a sketch of the patterns seen on the screen by the single slit and the double slit. Sketch the patterns one beneath the other. Your sketches should make it clear how the double slit pattern is similar to and different from the single slit pattern. Do you sketches match what you expect from the quantitative description using phasors?
- c) Now flip to the "multiple slits" section which contains single, double, triple, quadruple and sextuple (5) slit patterns. All of the slits have the same width and the distance between the slits of the multi-slit patterns is constant. Make sketches of triple and quadruple patterns produced on the screen. Use the phasor method from class and the problem set to qualitatively explain the maxima and minima of the patterns.

### Part II: Young's Double Slit Experiment

Devise a procedure to measure the wavelength of light from a double slit pattern. Choose a double slit and make the necessary measurements needed to determine the wavelength of the laser light. Your choice of slit makes this measurement more or less precise, so choose a double slit that maximizes the precision. Calculate the wavelength of the laser. Estimate the uncertainty of each of your measurements and determine the resulting uncertainty in the wavelength. Assume the slit width and spacing have negligible uncertainties. Think about uncertainties and refine your experiment, if you see ways to improve your result!