Experiment 17: Interference and Diffraction

Vernier Apparatus

The experiments will work best with the lights off and shades drawn. Ambient daylight or room lighting will overwhelm the laser beam's signal in the light sensor. You can use light from the computer monitors, night lights at the table, or their smartphone to see what you're doing!

Setup and Calibration

The apparatus consists of a diode laser (with $\lambda = 635 \pm 5$ nm, a slit system, and a combination position/light sensor, all mounted on an optics track. The light sensor includes an aperture dial with a variety of entrance slit widths, as well as fully open and fully closed apertures. These aperture slits are used to limit the acceptance of the sensor in the horizontal direction, to optimize the spatial resolution of the overall system. (They do *not* create the diffraction and interference patterns for this lab.) The aperture choice is a tradeoff between light quantity and spatial resolution. Faint, broad patterns are best studied with wider slits, while bright, highly detailed patterns will require narrower slits. The 0.3 mm or 0.5 mm slits are a good place to start.

The light sensor has three sensitivity levels. For most applications, the middle setting (10 μW) will be fine, but for diffuse interference patterns, you might need to increase the sensitivity to 1 μW.

You will want to zero the sensors. Move the position sensor to the far right edge of its track (as viewed from the laser), and choose the fully closed aperture. Press the "zeroing" button in Logger Pro to set the zero of position and light intensity.

For every part of the experiment, you will also need to adjust the laser beam direction using the two thumbscrews on the back of the laser. One screw rotates the laser horizontally, the other vertically. First adjust the horizontal thumbscrew until the pattern emerging from the slit system looks brightest (you might hold a piece of paper just after the slit system to judge the brightness). Then move the light sensor into the center of the light pattern, and choose a fairly wide aperture setting. Finally, adjust the vertical thumbscrew until the light sensor reading is at its largest; that should be when the laser pattern hits the center of the top entrance aperture.

Data Collection Procedure

- Start with the light sensor at the far right of its track.
- Start the data collection. Logger Pro will continue to collect data for 30 seconds by default.
- Slowly and smoothly move the light sensor across the full width of its track. Remember, you have 30 seconds to cover that distance. If you move too quickly, the light sensor won't have time to accurately respond to variations in the light pattern.
- Now you have a graph of intensity versus position. You can zoom in on individual peaks or troughs of the graphed pattern in order to accurately record their positions or intensities.

Experiments

The Vernier slit system has single slits with the same widths as in the original lab writeup, and offers a set of double slits with the same separation and width as the original setup. For the double slits with the largest separation d, the light sensor aperture should probably be set to something narrow like 0.1–0.2 mm.

Unfortunately, this slit system doesn't offer a diffraction grating. In lieu of that, students can investigate the differences in the interference pattern as the number of slits changes: 2, 3, 4, 5. How does the spacing of the maxima and minima vary? How does the intensity change? How does the "sharpness" of the intensity peaks change?