

Diffraction of Light

Using Vernier Labquest, and Vernier Light Sensor (LS-BTA)

This experiment is a complement to the *Physics with Vernier* lab manual experiment #29.

Diffraction: The effects of diffraction of light were first carefully observed and characterized by Francesco Maria Grimaldi, who also coined the term *diffraction*, from the Latin *diffringere*, 'to break into pieces', referring to light breaking up into different directions. Diffraction is a process that a wave undergoes when it encounters an obstacle with size close to its wavelength (Fig 1). It can be described as the apparent bending of waves around small obstacles and the spreading out of waves past small openings. Diffraction occurs with **all** waves, including sound waves, water waves, and electromagnetic waves such as visible light, x-rays and radio waves.

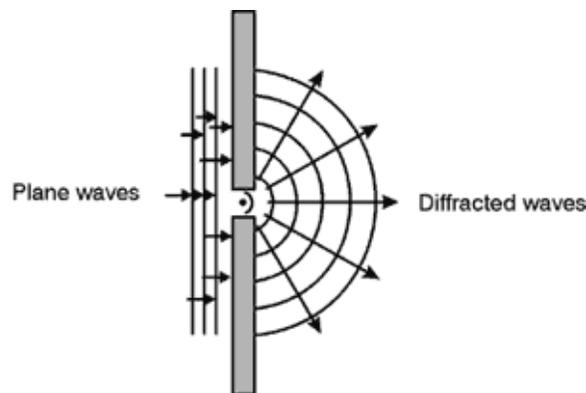


Figure 1

The effects of diffraction can be regularly seen in everyday life. The most colorful examples of diffraction are those involving light; for example, the closely spaced tracks on a CD or DVD act as a diffraction grating to form the familiar rainbow pattern we see when looking at a disk. Diffraction in the atmosphere by small particles can cause a bright ring to be visible around a bright light source like the sun or the moon. A shadow of a solid object, using light from a compact source, shows small fringes near its edges. The speckle pattern that is observed when laser light falls on an optically rough surface is also a diffraction phenomenon. All these effects are a consequence of the fact that light is a wave.

In optics, a **diffraction grating** is an optical component with a regular pattern, which splits and diffracts light into several beams travelling in different directions. The directions of these beams depend on the spacing of the grating and the wavelength of the light so that the grating acts as a dispersive element.

Objective:

In this experiment, we will investigate the relationship between the distance of a diffracting grating and the spacing between the diffracted beams of a laser using the LabQuest and a light sensor. We will also be using a laser pointer, so:

- **NEVER** look into a laser beam
- **NEVER** point a laser towards someone else's face (or your own)
- **THIS ACTIVITY MUST BE DONE UNDER ADULT SUPERVISION**

Materials:

Vernier Labquest
 Vernier Light Sensor (LS-BTA)
 Laser pointer
 Diffracting grating slide
 2 small boxes (one for mounting the laser and the other for mounting the sensor)
 Large cardboard sheet (at least 8 ½ inches by 11 inches, for mounting the screen)
 8 ½ inches by 11 inches sheet of white paper
 2 rulers
 Pencil

Initial Setup:

1. Tape the diffracting grating at the edge of the small box (perpendicular to the surface of the box) so that there is a clear line of sight through the surface of the box.
2. Tape the laser pointer onto the surface of the box perpendicular to the diffracting grating slide.
3. Tape the light sensor onto the surface of the other box so that the opening of the sensor is at the same height as the laser.
4. Pierce a hole (about the diameter of the opening of the light sensor) through the cardboard sheet and mount, with tape, the sheet of cardboard to the light sensor box.
5. Tape a piece of white paper to the face of the light sensor. This is the screen for measurements of the distance between spots.

Procedure:

1. Place the screen and the laser 2cm apart. Turn on the laser and measure the distance between the center spot and the spots on the right and left. Record the distances and repeat the measurement moving the screen and the laser apart every 1cm each time.

Screen-Laser Distance	Distance Between Middle and Left Spots (cm)	Distance Between Middle and Right Spots (cm)	Average Distance (cm)
2 cm			
3 cm			
4 cm			

2. Remove the white sheet of paper used to cover the sensor.

3. Turn on the LabQuest and plug in the light sensor to channel 1.
4. Set the light sensor range to 0-600 lux.
5. Change to "GRAPH" mode on the LabQuest.
6. With the laser at 2cm from the light sensor and all the laser spots to the left of the light sensor, turn the graphing data collection on (green arrow at the bottom of the screen on the LabQuest).
7. Maintain the laser on while moving the spots carefully across the sensor opening so that a graph representing the 3 spots appear on the screen.
8. Turn the graphing data collection off (red square at the bottom of the screen on the LabQuest).
9. Repeat until satisfied with the graph.
10. Once a suitable graph is chosen, click "File", "Save" to save the data into the LabQuest.
11. Retrieve the data by changing to "X|T" mode on the LabQuest and save the data as a .txt file.
12. Copy the data to an EXCEL file and graph the results.