

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, traveling microscope, magnifying glass, jackstand, compact disc, retort stand with clamp, mounted meter stick, tape measure, two meter ruler, 30cm ruler

Part I: 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.

Choose your favorite double slit and make the measurements needed to determine the wavelength of the laser light. You can use the traveling microscope to measure the slit spacing. Calculate the wavelength of the laser. Estimate the uncertainty of each of your measurements and determine the resulting uncertainty in the wavelength. Be sure to include a description of your procedure with your result.

Part II: Using interference and diffraction

In part I 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. A compact disc (CD or DVD) 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.

A compact disc is used to store information digitally, in other words, as a series of ON and OFF states (usually represented as 1's and 0's). A typical audio CD has three layers that make a 1.2 mm thick sandwich (See Fig. 1). The bottom layer is made of polycarbonate plastic and contains over a billion tiny pits, about 100 nm deep. A thin reflecting layer of aluminum is adhered to the polycarbonate and the aluminum is covered with a layer of acrylic lacquer. The aluminum fills in the pits in the polycarbonate, resulting in bumps in the aluminum layer, as viewed from below in Fig. 1.

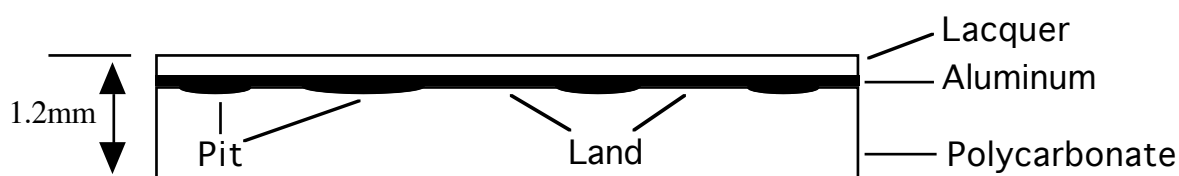


Figure 1. Cross-sectional view of CD (not to scale)

The pits are arranged in a long spiral track, as shown in Figs. 2 and 3. The length and spacing of the pits corresponds to the information being stored.

To "read" the CD, a laser beam is focused to a tiny spot, and shone onto the spinning disc from underneath. A motor controls the position of the laser so that it follows the spiral track. A light detector, positioned near the laser receives the light reflected by the aluminum and produces a voltage proportional to the intensity of the light. As the pits and lands move past the laser spot the intensity of the reflected light varies, and the light detector thus produces a varying electrical signal of high and low voltages.

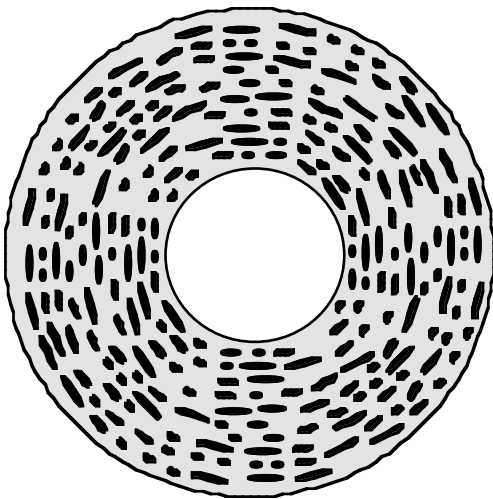


Fig. 2 Schematic of a CD

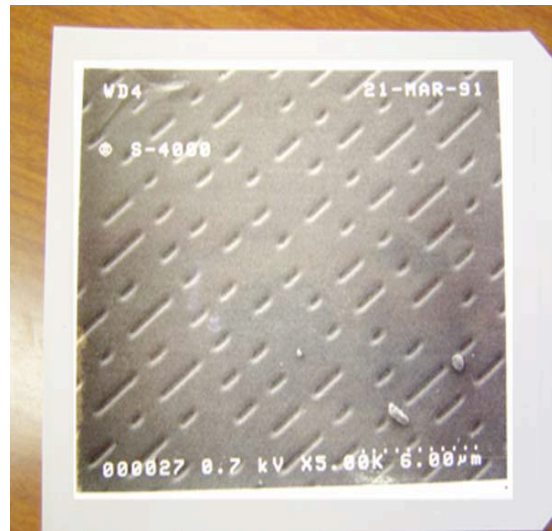


Fig. 3 Electron Micrograph of a CD. Courtesy K. Bart, Hamilton College, Biology Dept.

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 track.