3.6.8.1: Interference

If two sources of waves are in phase to start with, when they reach a distant location they may be in-phase (leading to constructive interference) or out-of-phase (leading to destructive interference) depending on slight differences in the distance traveled. This ***path difference*** gives rise to many interesting phenomena such as interference patterns (in the case of light) and dead spots in auditoriums (in the case of sound). The colors on a soap bubble and an oil slick are caused by path differences.

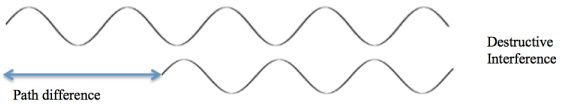

Figure 3.6.8.1.1

Video/audio examples:

- Two source ripple tank. You are looking down onto a tray of water where two circular waves are being formed. On a line directly in front of the waves (perpendicular to a line connecting the two sources) there is constructive interference. At angles on either side are lines of destructive interference. This is because the waves travel the same distance to reach the points straight out in front but waves arriving at the destructive points have traveled different distances.
- Simulation of double slit interference from Wolfram (you may need to download their plug in to play with this demonstration).
- CD and DVD disks also have colors that depend on the angle at which they are viewed. This is because the data is recorded as tiny pits in the disk (as we will discuss later). Light reflected from the bottom of the pits travels a different distance than light from the surface leading to constructive or destructive interference depending on the wavelength. CD diffraction. [Note: This is sometimes called diffraction which we discuss next but it is really a path difference effect.]
- DVD and Blu-Ray diffraction.
- Many bird feathers and moth wings have colors that change with the angle. So what color are they really? When you look at them under a microscope you see they actually don't have a color. Instead there are layers of feathers (or scales in the case of moths or butterflies). Light reflecting off each different layer travels a different distance back to your eye so some colors will undergo destructive interference while others will have constructive interference. The path difference is slightly different at different angles, hence the changing colors. Here is a video of some peacocks which get their colors from interference rather than pigment in the feather.
- An example of a butterfly changing colors due to angle. Why does the color depend on the angle?
- Why do soap bubbles have colors? Light reflects off the inside and outside surfaces of the soap film that makes up the bubble. The light off the inside surface has to travel slightly further to get to your eyes than light reflecting off the outside surface. Different colors of light have different wavelengths. The path difference can cause destructive interference for some wavelengths while causing constructive interference for other colors. Here is a video of soap bubbles.
- Mini Lab on Interference.