7. JUST FOR THE FUN OF IT

This part of the Lab is, as the name suggests, for fun. You don't have to write a report about this section. The idea is to introduce you to concepts that are very exciting but are normally not discussed in freshmen physics courses. The experiment will give you something to think about. If you would like to pursue these concepts further, we would be very happy to direct you to additional reading material and/or discuss the significance of observations you have made.

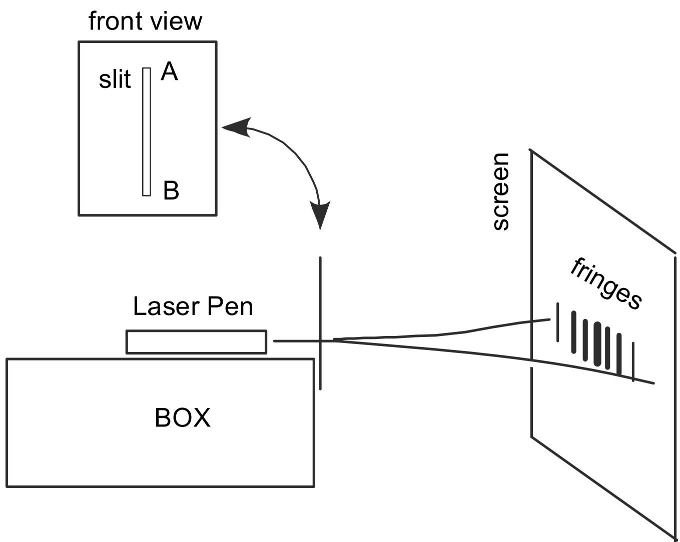

Figure 2. Diffraction using a Laser pointer.

The laser light you have used for the SOL experiment can be viewed either as a wave or as a stream of photons (quanta of energy). When light interacts with objects that are comparable to its wavelength, it can behave in very counterintuitive ways. This experiment is designed to illustrate this.

Take a sheet from the pad and put it on a flat surface. With a razor blade make a cut about 3cm long. Turn the box upside down and paste the slit paper on the box as shown. Place the laser pen about 2 to 4 cm behind the slit. Adjust the position of the pen and/or slit so that the slit is roughly in the middle of the laser spot.

Let the laser light after passing through the slit fall on a flat vertical white or light-colored surface about a meter away from the laser. If there is no such surface within your convenient reach, use a sheet of white paper as a screen. What you will see is a series of dark and bright fringes spread over several centimeters.

The fringes are caused by the interference between light waves originating from different parts of the slit. Bright fringes are formed when the waves are superimposed in phase and dark fringes result when the waves meet on the screen out of phase.

You should also notice that the beam has spread only along the width but not the length (height) of the slit. Here, you are seeing Heisenberg's uncertainty principle in action. This is what is going on. The photons that end up at the screen *must* have passed through the slit of width Δx. Therefore the position of a photon is known with a maximum uncertainty of Δx. According to Heisenberg's uncertainty principle, in a simultaneous measurement of position and momentum, the uncertainties in position (*Δx)*, and in momentum (*Δp)* must obey $\Delta x \Delta p \geq h/2\pi$ where $h = 6.6*10^{-34} J.s$ is a fundamental constant of nature and is known as the Planck's constant. Thus if you decrease *Δx, Δp* – the uncertainty in the *x*-component of the photon's momentum - must increase. This is what makes the laser spot 'spread' in the direction of the slit's width (but not along the length where the confinement length is much larger) You can easily observe the inverse dependence of *Δx* on *Δp* by twisting/bending the slit gently (please ask your lab instructor how to do it.)

For further reading, please refer to the chapter of your textbook discussing Heisenberg's Uncertainty Principle.