MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Physics Department

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Take-Home Experiment #8

DIFFRACTION OF LIGHT

Objective In this experiment you will investigate simple diffraction phenomena by using the small filament of the mini-maglite to approximate a point source.

Experiments Unscrew the front 4 cm. long section of the mini-maglite (the part containing the reflector) and use it as a stand for the light. Press down on the ring around the bulb stem in order to turn the light off while you inspect the bulb (you may want to use one of the lenses from the Newton's Rings experiment as a magnifier). Note that the coiled filament forms an arch. You will want to orient the light so that you are looking at this arch from the side to obtain the smallest possible source width. This means that one of the two brown stripes (the wire leads) in the bulb stem should be facing you when you do the following experiments.

Single Slit Place the light as far away in a room as possible. It will help to dim the room lights and sit in a comfortable position. The conventional method of seeing the fringes is to make a slit in tin foil with a razor blade. Try it. Holding the foil close to your eye, look at the source. Try slits of different width.

Now try a more systematic approach. Tape two razor blades together in the same plane, facing each other with their blade edges nearly touching. The separation should be just perceptible at one end and a few tenths of a millimeter at the other. Look at the source through this variable width slit. Move the slit up and down in front of you eye to change the spacing of the fringes. See if the fringes appear more distinct, or if you can see more of them, when viewed through a colored filter.

Try to find a vernier caliper that you can use for a few minutes. View the source through the jaws as you slowly close them. Remember to hold the "slit" fairly close to your eye.

Airy Rings Use a pin to make round holes of various sizes in the tin foil. Hold the foil close to your eye and observe the circular ring pattern associated with the diffraction.

Rectangular Aperture To make a rectangular aperture use the double razor blade slit and a tin foil slit held together at right angles. Observe that the diffraction pattern rotates with the aperture. How does the pattern change if the two slits are not at right angles?

Double Slit Again the standard method is to make two parallel, closely spaced slits in

the tin foil. It takes some practice to get satisfactory results. I find it useful to use a ruler to make the slits, and then to do some adjusting of the position of the center strip afterward with the tip of the razor blade. One can also open the slit width somewhat by pulling on the foil perpendicular to the direction of the slits.

Another more controlled approach involves two taped razor blades again. This time make the the gap between the sharp edges a uniform width of several tenths of a millimeter. Take a length of fine wire and secure one end near the top of the gap, centered as well as possible. Leave the other end of the wire free so that you can move it to get the best centering in the gap half way down the slit as you view the distant source. Experiment with different blade gaps and wire sizes to get the most pleasing two slit diffraction pattern. Notice how the interference zeros (closely spaced) and the diffraction zeros (more widely spaced) change with the separation and width of the two slits.

Multiple Slit Diffraction View the source through a fine-toothed comb. What happens to the pattern as you change the angle of the comb relative to the line of sight (thus decreasing the effective spacing between the slits)? Can you find other common objects that can act as simple multiple slit arrays? What about a transparent ruler marked in millimeters?

Two-dimensional Diffraction Grating Now view the source through a piece of finely woven cloth. A handkerchief is one good candidate. Try several samples with different thread spacing. How does the diffraction pattern depend on the coarseness of the weave?