

**Experiment General Diffraction**

**EQUIPMENT NEEDED:**
- Optics Bench
- Component Holders (2)
- Diffraction Plate
- Color Filter (any color)
- Light Source
- Variable Aperture
- Slit Mask
- Black Construction Paper

**Introduction**

The simplest diffraction patterns are produced by narrow slits. However, any aperture, or collection of apertures, will produce a diffraction pattern if the dimensions of the apertures are of the same order of magnitude as the wavelength of visible light.

The diffraction pattern created by a particular aperture can be determined quantitatively using Huygen’s principle. Simply treat each aperture as a collection of point sources of light (small, closely packed points will give the best approximation of the diffraction pattern). At any position on your viewing screen, determine the phase of the light contributed by each point on the aperture. Finally, use the superposition principle to sum the contributions from all the points on the aperture.

Of course, you must perform this same calculation for each point on your viewing screen to determine the complete diffraction pattern—a time consuming task. In this experiment the approach will be more qualitative. You will use your knowledge of diffraction patterns formed by slits to understand the patterns formed by more complicated apertures.

**Procedure**

Setup the equipment as shown in Figure 17.1. Begin with the Variable Aperture fully open. Looking through the Diffraction Plate at the Light Source filament, examine the diffraction patterns formed by Patterns H, I, and J.

While looking through Pattern H, slowly close the Variable Aperture. Repeat this with Patterns I and J.

1. What effect does aperture size have on the clarity of the diffraction patterns?
2. What effect does aperture size have on the brightness of the diffraction patterns?

Adjust the Variable Aperture to maximize the brightness and clarity of the pattern. Place a color filter over the Light Source Aperture.

3. In what way does the color filter simplify the diffraction patterns that are formed?
Crossed Slits
Examine the diffraction pattern formed by aperture H, the crossed slits. As you watch the pattern, slowly rotate the Diffraction Plate so first one slit is vertical, then the other.

1. Describe the diffraction pattern in terms of the patterns formed by each individual slit.

Random Array of Circular Apertures
Examine the diffraction pattern formed by aperture I, the random array of circular apertures. The pattern is similar to that formed by diffraction through a single circular aperture. To verify this, use a pin to poke a small hole in a piece of black construction paper. Look at the Light Source filament through this hole. In the pattern formed by the random array, the patterns from all the circular apertures are superposed, so the combined diffraction pattern is brighter. In the random array, smaller circles are used than you can produce with a pin.

1. What effect does the smaller diameter of the circles have on the diffraction pattern?
   In observing single slit diffraction, you found that the narrower the slit, the greater the separation between the fringes in the diffraction pattern. This is generally true. For any aperture, diffraction effects are most pronounced in a direction parallel with the smallest dimension of the aperture.

2. Use the above generalization to explain the symmetry of the diffraction pattern formed by a circular aperture.

Square Array of Circular Apertures
Examine the diffraction pattern formed by aperture J, the square array of circular apertures.

1. How is this pattern similar to that formed by the random array? How is it different?
   Each circular aperture in the array forms a circular diffraction pattern with maxima and minima appearing at different radii. However, the regularity of the array causes there to be interference between the patterns formed by the individual circles. This is analogous to the way in which the double slit interference pattern creates maxima and minima that are superimposed on the single slit patterns created by the individual slits.

2. On a separate sheet of paper, draw the diffraction pattern you would expect if there were no interference between the patterns from the different holes (as in the random array). Clearly indicate the maxima and the minima.

3. To understand the interference that takes place, consider the array of points as if it were actually a collection of parallel slits, such as those shown in Figures 17.2a, b, and c. Draw the diffraction patterns that would be created by each of these collections of parallel slits. Clearly label the maxima and minima.

4. Your drawing from step 2 shows where the light is diffracted to from each individual circular aperture. To approximate the effect of interference between circular apertures, superimpose a copy of one of your interference patterns from step 3 over your drawing from step 2. Only where maxima overlap, will there be maxima in the combined pattern. Repeat this procedure for each of your interference drawings.

Figure 17.2 Square Array Interference