Experiment Single Slit Diffraction

Equipment Needed:
- Optical Bench
- Ray Table Base
- Component Holder
- Slit Mask
- Light Source
- Diffraction Scale
- Diffraction Plate
- Color Filters (Red, Green, Blue/Green). Perform in a well lighted room.

Introduction

If you look closely at a two slit interference pattern, you will notice that the intensity of the fringes varies. This variation in intensity forms an interference pattern of its own that is independent of the number of slits or the separation between the slits. In fact, two slits are not required to see this pattern; it can be seen most clearly when light passes through a single, narrow slit.

In this experiment you will compare the single slit diffraction pattern with the double slit pattern, and then use the single slit pattern to measure the wavelengths of red, green, and blue light.

Procedure

Setup the equipment as shown in Figure 16.1. Look through each of the three single slit apertures in the Diffraction Plate (Patterns A, B, and C). Examine the diffraction patterns with and without color filters over the aperture of the Light Source.

1. How does the spacing between fringes vary with the width of the slit?

Compare the single slit patterns with the double slit patterns.

2. How does a double slit interference pattern differ from a single slit pattern? (Compare patterns of equal slit widths, such as A vs D, or B vs E.)
The single slit pattern can be explained using Huygen's theory. When a plane wave front strikes the slit, each point on the slit acts as a point source of light. Figure 16.2 shows a point P, far from the slit, where the distance AP = BP + λ. Since light from point A travels one wavelength farther than light from point B, the light from these two points is in phase at point P. But light reaching point P from the points in between A and B will vary in phase through a full 360°. For any point from which light reaches point P at a particular phase, there will be a point from which light arrives in the exact opposite phase. Because of this, there is complete cancellation at point P, and a minima (dark fringe) will be seen at that point.

In the Figure, point P is at an angle θ from the center of the slit. We make the assumption that point P is far enough away such that AP and BP are very nearly parallel (this is true in reality, if not in the diagram). As shown in the diagram, angle ABC = θ, also. Therefore W sin θ = λ, where W is the width of the slit (AB). A similar argument can be used to show that a minima will be found at any angle such that W sin θ = nλ, where n is any integer.

Review the two slit interference experiment. Notice the similarity between the equations for single and double slit patterns. To measure the wavelength of light, use the same techniques you used in the two slit experiment (θ = arctan X/L). When measuring the distance to the minima (x) for each color, place the Color Filter on the front of the Light Source. Use your data to fill in Table 16.1, then perform the calculations shown to determine the wavelength of Red, Green, and Blue Light.

3 If the width of the slit, W, were less than the wavelength of the light being used, how many maxima would you expect to see in the single slit diffraction pattern? Why?

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**Table 16.1**

<table>
<thead>
<tr>
<th>Color</th>
<th>n</th>
<th>W</th>
<th>X</th>
<th>L</th>
<th>arctan X/L</th>
<th>Wsin (arctan X/L) = nλ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td></td>
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<tr>
<td>Green</td>
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<tr>
<td>Blue</td>
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