Experiment 6: Double-Slit Interference

EQUIPMENT NEEDED:

- Transmitter, Receiver
- Component Holder
- Slit Extender Arm
- Wide Slit Spacer
- Goniometer, Rotating
- Metal Reflectors (2)
- Narrow Slit Spacer

Introduction

In Experiment 3, you saw how two waves moving in opposite directions can superpose to create a standing wave pattern. A somewhat similar phenomenon occurs when an electromagnetic wave passes through a two-slit aperture. The wave diffracts into two waves which superpose in the space beyond the apertures. Similar to the standing wave pattern, there are points in space where maxima are formed and others where minima are formed.

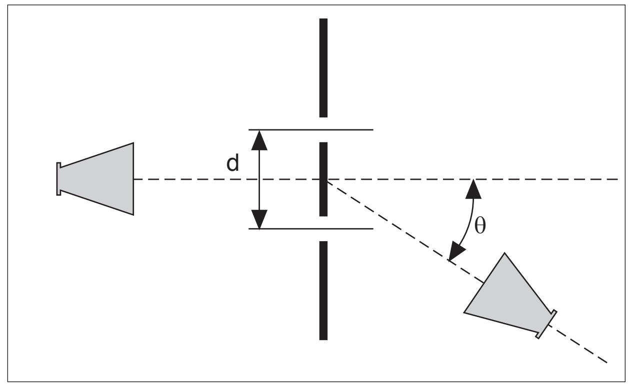

Figure 6.1 Double-Slit Interference

With a double slit aperture, the intensity of the wave beyond the aperture will vary depending on the angle of detection. For two thin slits separated by a distance **d**, maxima will be found at angles such that **d sin**θ **= n**λ. (Where θ = the angle of detection, λ = the wavelength of the incident radiation, and **n** is any integer) (See Figure 6.1). Refer to a textbook for more information about the nature of the double-slit diffraction pattern.

Procedure

① Arrange the equipment as shown in Figure 6.2. Use the Slit Extender Arm, two Reflectors, and the Narrow Slit Spacer to construct the double slit. (We recommend a slit width of about 1.5 cm.) Be precise with the alignment of the slit and make the setup as symmetrical as possible.

② Adjust the Transmitter and Receiver for vertical polarization (0°) and adjust the Receiver controls to give a full-scale reading at the lowest possible amplification.

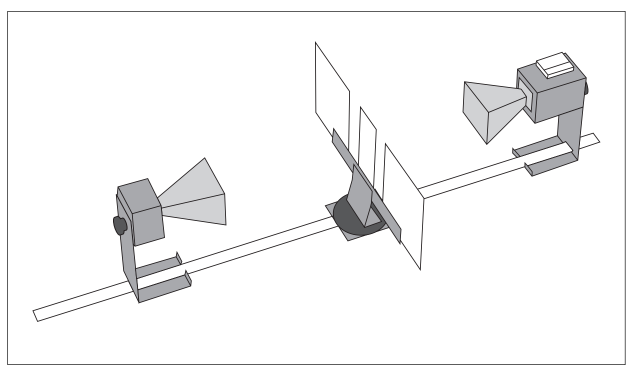

Figure 6.2 Equipment Setup

③ Rotate the rotatable Goniometer arm (on which the Receiver rests) slowly about its axis. Observe the meter readings.

④ Reset the Goniometer arm so the Receiver directly faces the Transmitter. Adjust the Receiver controls to obtain a meter reading of 1.0. Now set the angle θ to each of the values shown in Table 6.1. At each setting record the meter reading in the table. (In places where the meter reading changes significantly between angle settings, you may find it useful to investigate the signal level at intermediate angles.)

⑤ Keep the slit widths the same, but change the distance between the slits by using the Wide Slit Spacer instead of the Narrow Slit Spacer. Because the Wide Slit Space is 50% wider than the Narrow Slit Spacer (90mm vs 60mm) move the Transmitter back 50% so that the microwave radiation at the slits will have the same relative intensity. Repeat the measurements. (You may want to try other slit spacings as well.)

Table 6.1

Angle	Meter Reading	Angle	Meter Reading
0°		45°	
5°		50°	
10°		55°	
15°		60°	
20°		65°	
25°		70°	
30°		75°	
35°		80°	
40°		85°	

Questions

① From your data, plot a graph of meter reading versus θ. Identify the angles at which the maxima and minima of the interference pattern occur.

② Calculate the angles at which you would expect the maxima and minima to occur in a standard two-slit diffraction pattern—maxima occur wherever $\mathbf{d}\ \mathbf{sin}\theta = \mathbf{n}\lambda$, minima occur wherever $\mathbf{d}\ \mathbf{sin}\theta = \mathbf{n}\lambda/\mathbf{2}$. (Check your textbook for the derivation of these equations, and use the wavelength measured in experiment 3.) How does this compare with the locations of your observed maxima and minima? Can you explain any discrepancies? (What assumptions are made in the derivations of the formulas and to what extent are they met in this experiment?)

③ Can you explain the relative drop in intensity for higher order maxima? Consider the single-slit diffraction pattern created by each slit. How do these single slit patterns affect the overall interference pattern?

➤ **NOTE:**

① Wavelength at 10.525 GHz = 2.85 cm.

② The experimenter's body position may affect the results.