DOUBLE SLIT INTERFERENCE

INTRODUCTION:

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 a standing wave pattern, there are points in space where maxima are formed and others where minima are formed. 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

$$d \sin\theta = n\lambda \qquad (1)$$

and minima will be found at angles such that

$$d \sin\theta = n\lambda/2, \qquad (2)$$

where θ = the angle of detection, λ = the wavelength of the incident radiation, and n is any integer. See Figure 1. Refer to a textbook for more information about the nature of the double-slit diffraction pattern and the derivations of equations (1) and (2).

PROCEDURE:

1. Arrange the equipment as shown in Figure 2. Use the Slit Extender Arm, two Reflectors, and the Narrow Slit Spacer to construct the double slit. (Use 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.

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

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[*] taken from PASCO Scientific laboratory write-ups

4. Reset the Goniometer arm so the Receiver directly faces the Transmitter. Adjust the Receiver controls to obtain a meter reading of 1.0. Vary the angle θ for every two degrees from 0 to 80 degrees. At each setting record the meter reading. (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 (90 mm vs. 60 mm) move the Transmitter back 50% so that the microwave radiation at the slits will have the same relative intensity. Repeat the measurements.

ANALYSIS:

1. Present your data in an appropriate data. 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. Be certain to label your graph properly.

2. Calculate the angles at which you would expect the maxima and minima to occur in a standard two-slit diffraction pattern. Refer to equations (1) and (2). Determine the percentage error between the calculated maxima and minima and the locations of your observed maxima and minima

3. Plot a graph of $\sin\theta$ vs. n for your data at each maximum observed. Determine the best fit straight line for your data with the constraint that the intercept is located at the origin. Given this constrain the slope of the best fit line is given by

$$b = \frac{\sum_{i=1}^{N} x_i y_i}{\sum_{i=1}^{N} x_i^2}. \quad (3)$$

QUESTIONS:

1. What assumptions are made in the derivation of equation (1) and to what extent are these assumptions met in this experiment?

2. Derive equation (1).

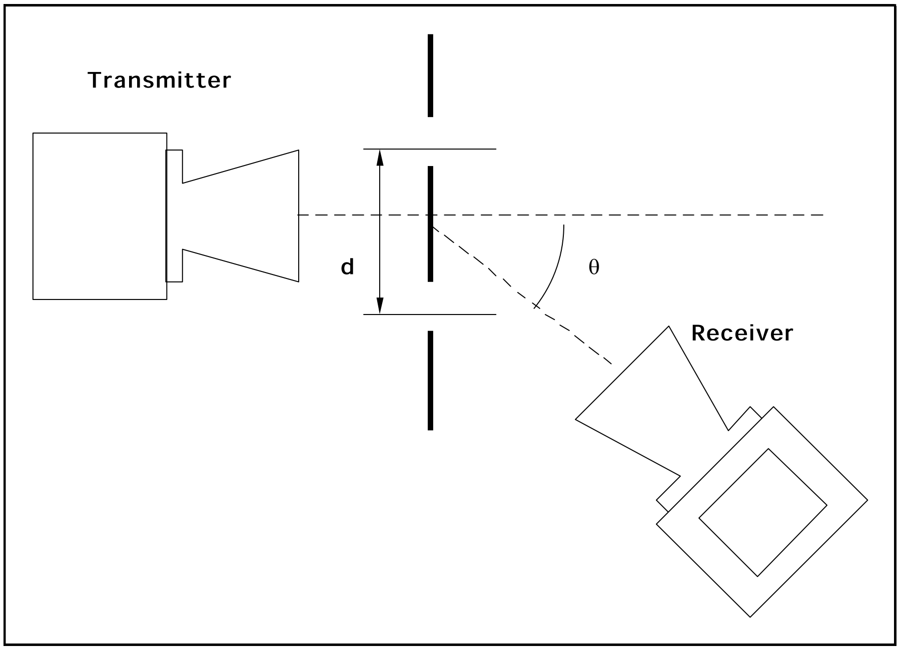

Figure 1. Double Slit Interference

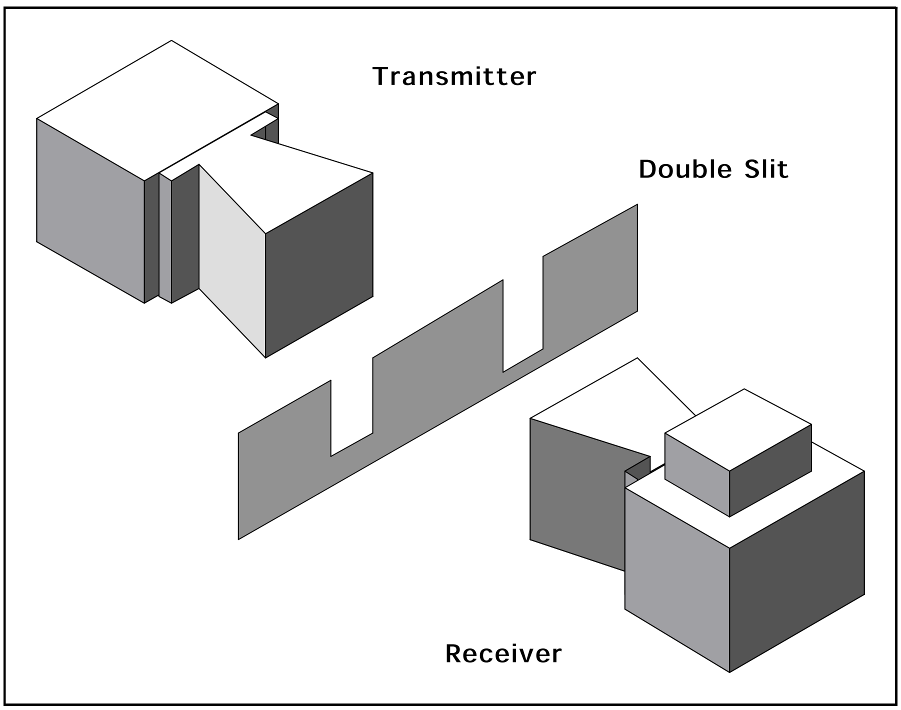

Figure 2. Equipment Setup.

NOTES:

1. Wavelength at 10.525 GHz = 2.85 cm
2. The experimenter's body position may affect the results.

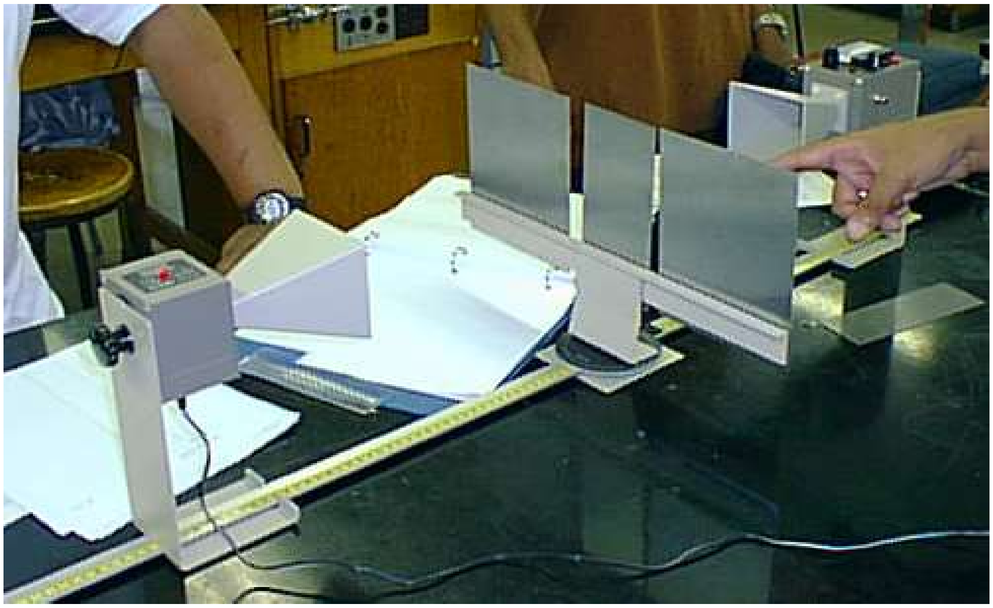

Figure 3. Photo of Setup