Experiments with a Microwave Emitter and Detector

Bret Comnes

Humboldt State University

(Dated: April 12, 2010)

Abstract

Using a tabletop microwave emitter and detector, we are able to observe the Bragg diffraction, double slit diffraction, and polarizations of sending microwaves through different mediums, gratings and polarizers. By using microwaves to observe these effects, the structures of the different mediums and apparatus are at a tangible scale, at a cost the visible effects. With the benefit of a real time data acquisition system, we can reduce that cost with realtime observables.

I. INTRODUCTION

When studying the wavelike nature of electromagnetic waves, there are numerous experimental setups to observer different phenomena. Procedures using optical wavelengths have the benefit of observables, where diffraction patters can be observed on screens. The different instruments such as polarizers and crystal latices, however, have to be on the scale of the wavelengths used. In the optical wavelength range, this means that the structures of these mediums and gratings are of such a small scale that they provide no direct tangible insight to their configurations. If microwaves are used, which in this case have a wavelength of 2.9cm, the instruments used to create the different diffraction patters are of a similar size and scale which allow for a direct physical insight into their configurations. This physical tangibility is beneficial to understanding what is actually happening when the diffraction patters are seen in observable wavelengths.

With this increased scale however, the experimenter loses all direct observable diffraction patterns, and must use a detector to gather data which can add a layer of obscurity to the exercise. If some form of automated data acquisition is used however, it is easy to develop systems that can provide near direct feedback of the data being observed. In this exercise, a simple LabVIEW program was utilized to sample data off of the microwave detector and display the amplitude on a realtime rolling graph. Not only did this increase the speed at which data was collected, it provided a real time picture to associate with the experimental setup which would normally not provide much real time feedback.

II. BRAGG DIFFRACTION

A. Bragg Diffraction Backround

Diffraction of electromagnetic waves off of the structures of crystal lattices can give important information about the normally invisible structures.

However, a method to confirm the mechanisms behind the technique, we can use a macroscopic crystal structure made up of a grid if 10mm steel balls held together with a styrofoam structure. The styrofoam is essentially transparent to the $\lambda = 2.9$ cm wavelength of microwaves generated by the emitter. In total, we have a 5 x 5 x 4 grid in our ‘crystal’ of 100 total steel balls.

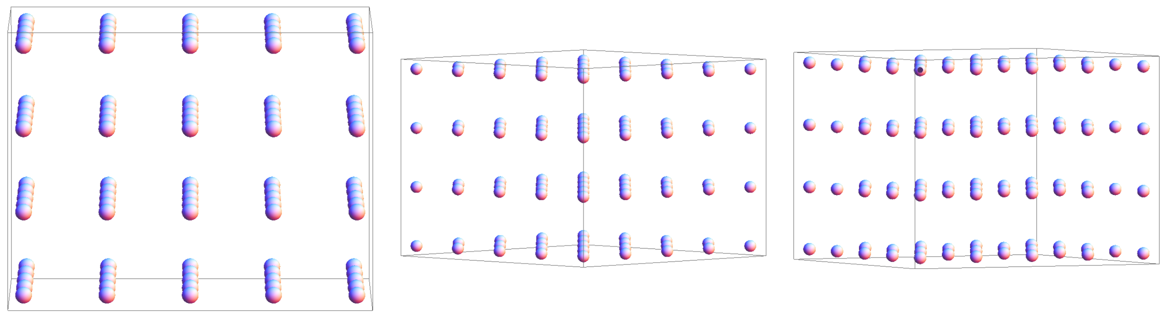

FIG. 1. caption

B. Procedure

C. Results

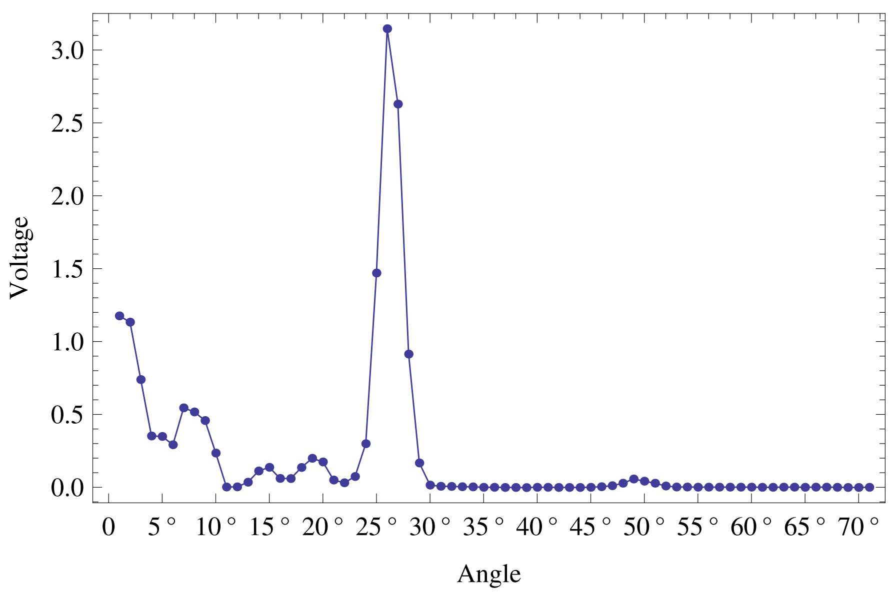

FIG. 2. Bragg Diffraction results (We have better data now, this is old)

III. DOUBLE SLIT DIFFRACTION

A. Double Slit Diffraction Background

B. Procedure

C. Results

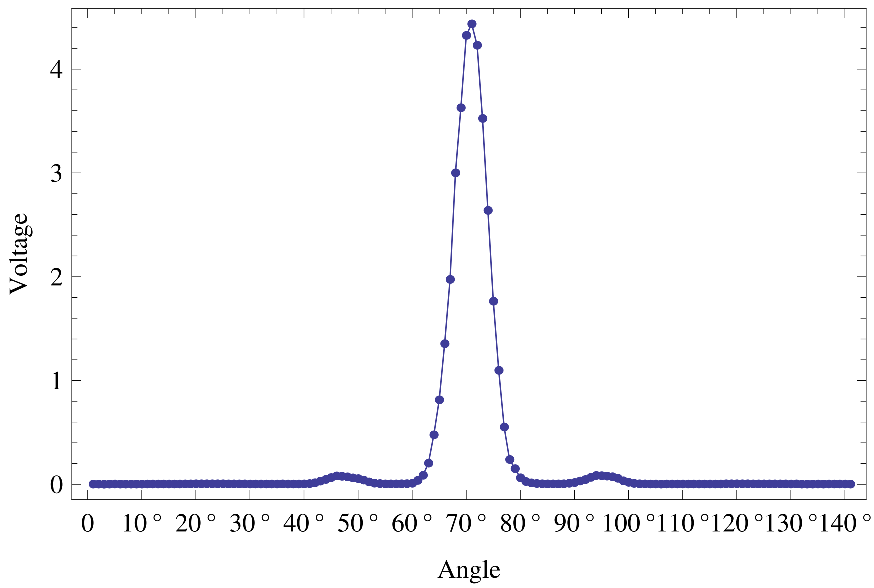

FIG. 3. caption

IV. MICROWAVE POLARIZATION

A. Polarization Background

B. Procedure

C. Results

V. CONCLUSION

I was not able to complete this lab writeup by the given deadline. Here is a some of the data we took. It had some issues so took some more, which is not included currently.

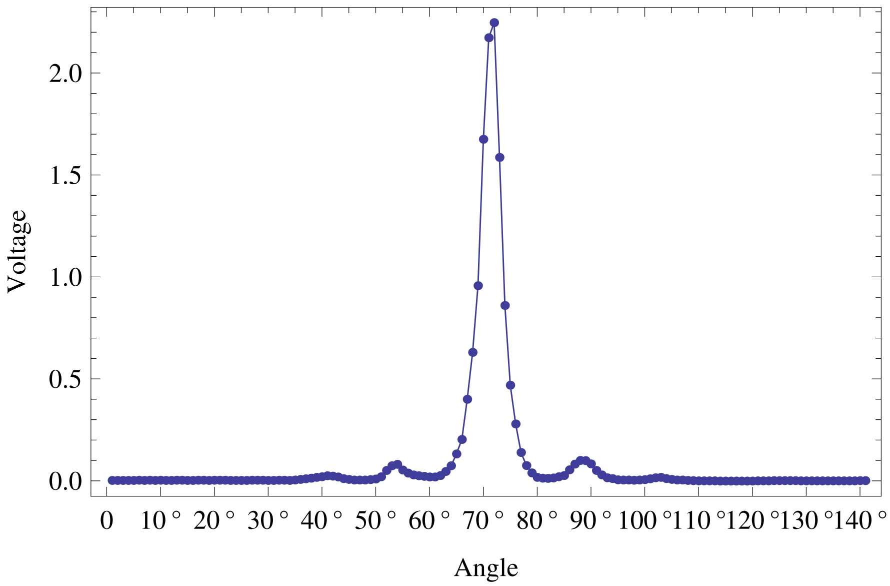

FIG. 4. caption

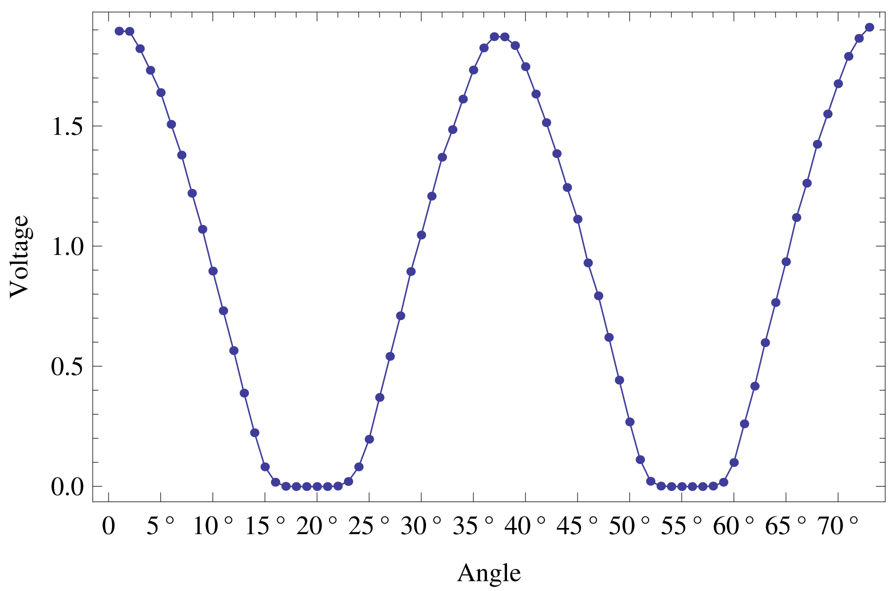

FIG. 5. caption

I intend on spending more time finishing this as soon as possible. I, however, have made significant headway on my personal senior project.

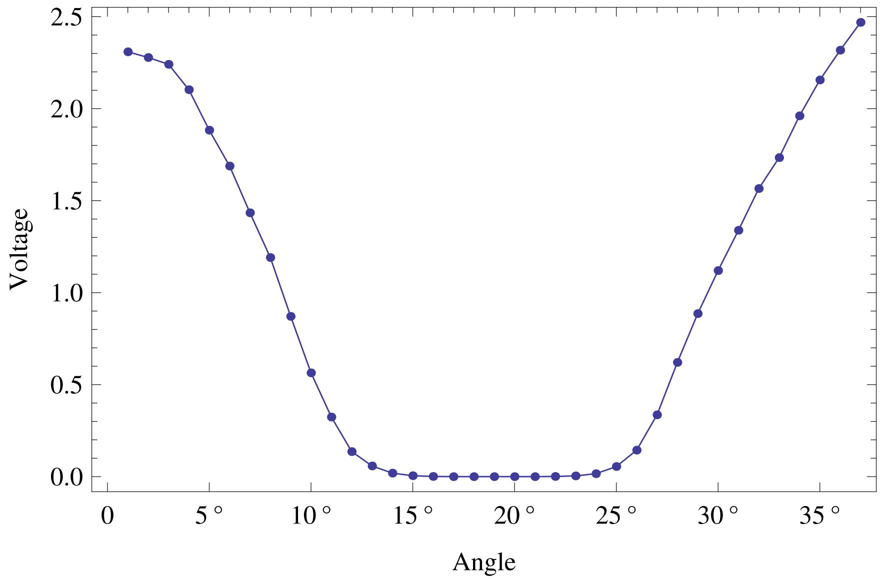

FIG. 6. caption

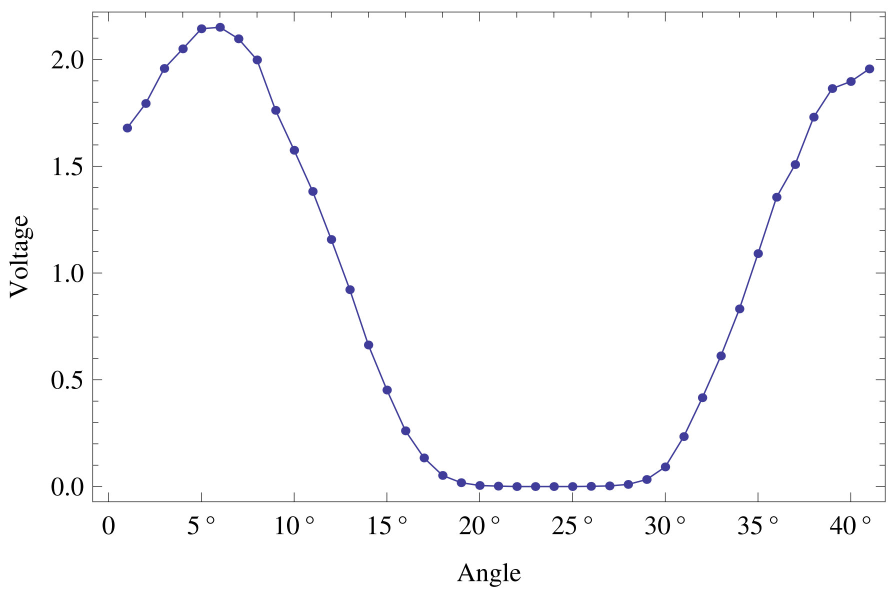

FIG. 7. caption

[1] Paul Horowitz and Winfred Hill. *The Art of Electronics 2nd ed.* Cambridge University Press, 1989.

[2] John Sprott. Simple chaotic systems and circuits. *American Journal of Physics*, 2002.

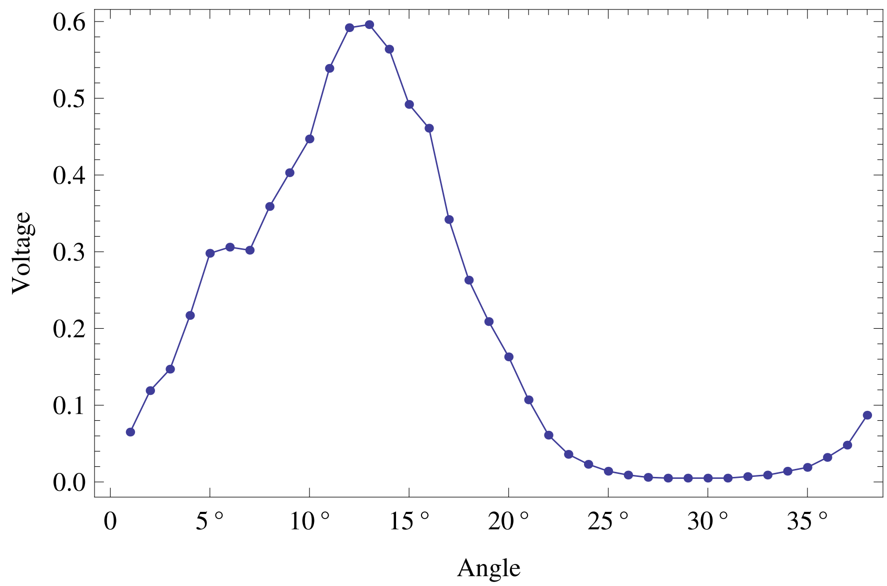

FIG. 8. caption

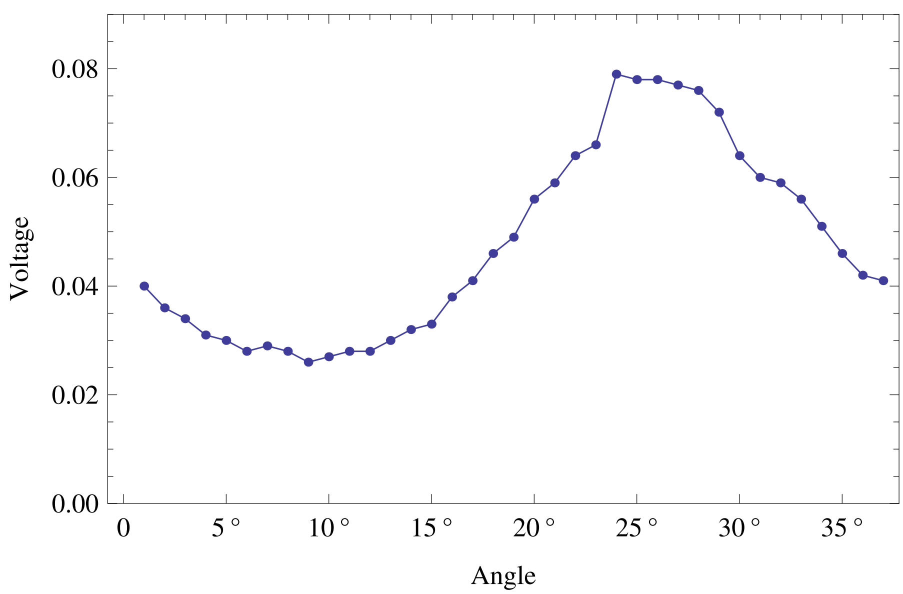

FIG. 9. caption

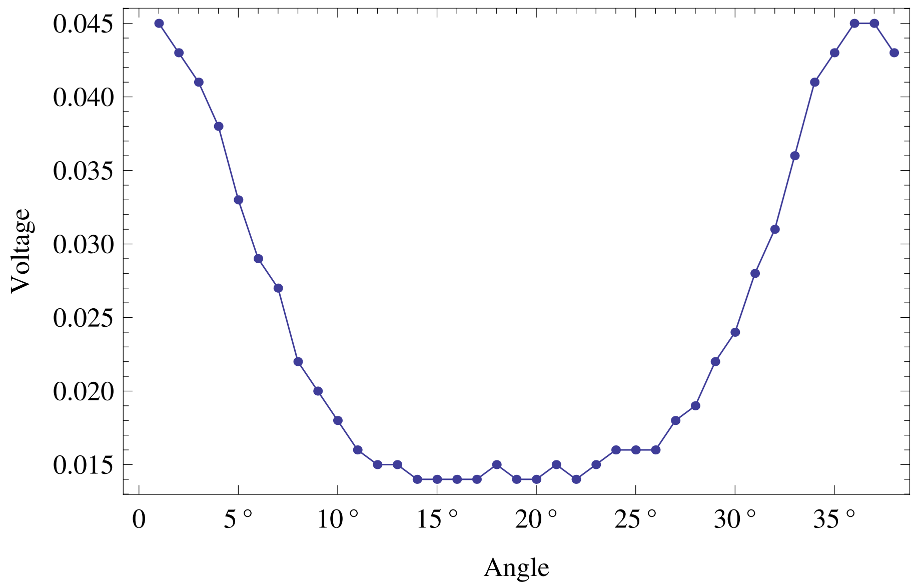

FIG. 10. caption