BRAGG DIFFRACTION

(Taken from PASCO Scientific laboratory write-ups)

INTRODUCTION:

Bragg's Law provides a powerful tool for investigating crystal structure by relating the interplanar spacings in the crystal to the scattering angles of incident x-rays. In this experiment, Bragg's Law is demonstrated on a macroscopic scale using a cubic "Crystal" consisting of 10-mm metal spheres embedded in an ethafoam cube.

Before performing this experiment, you should understand the theory behind Bragg Diffraction. In particular, you should understand the two criteria that must be met for a wave to be diffracted from a crystal into a particular angle. Namely, there is a plane of atoms in the crystal oriented with respect to the incident wave, such that:

1. The angle of incidence equals the angle of reflection, and

2. Bragg's equation, $2d \sin\theta = n\lambda$., is satisfied; where d is the spacing between the diffracting planes, θ is the grazing angle of the incident wave, n is an integer, and λ is the wavelength of the radiation.

PROCEDURE:

1. Arrange the equipment as shown in Figure 1.

2. Notice the three families of planes indicated in Figure 2. (The designations (100), (110), and (210) are the Miller indices for these sets of planes.) Adjust the Transmitter and Receiver so that they directly face each other. Align the crystal so that the (100) planes are parallel to the incident microwave beam. Adjust the Receiver controls to provide a readable signal. Record the meter reading.

3. Rotate the crystal (with the rotating table) one degree clockwise and the Rotatable Goniometer arm two degrees clockwise. Record the grazing angle of the incident beam and the meter reading. (The grazing angle is the complement of the angle of incidence. It is measured with respect to the plane under investigation, NOT the face of the cube; see Figure 3.)

4. Continue in this manner, rotating the Goniometer arm two degrees for every one degree rotation of the crystal. Record the angle and meter reading at each position. (If you need to adjust the INTENSITY setting on the Receiver, be sure to indicate that in your data.)

5. Repeat the steps above for the (110) family of planes.

ANALYSIS

1. Graph the relative intensity of the diffracted signal as a function of the grazing angle of the incident beam for each of the family of planes. At what angles do definite peaks for the diffracted intensity occur?

2 Use your data, the known wavelength of the microwave radiation (2.85 cm), and Bragg's Law to determine the spacing between the (100) planes of the Bragg Crystal. Measure the spacing between the planes directly, and compare with your experimental determination. Present your findings in an appropriately labeled table.

QUESTIONS:

1. What other families of planes might you expect to show diffraction in a cubic crystal? Would you expect the diffraction to be observable with this apparatus? Why?

2. Suppose you did not know beforehand the orientation of the "inter-atomic planes" in the crystal. How would this affect the complexity of the experiment? How would you go about locating the planes?

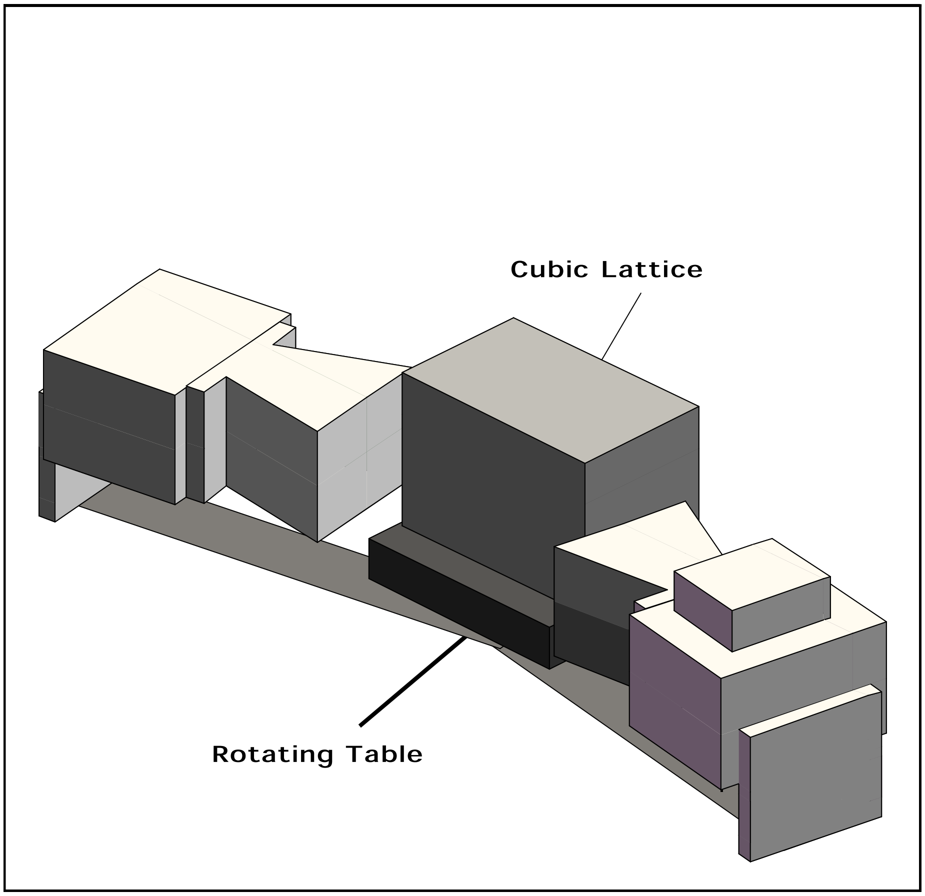
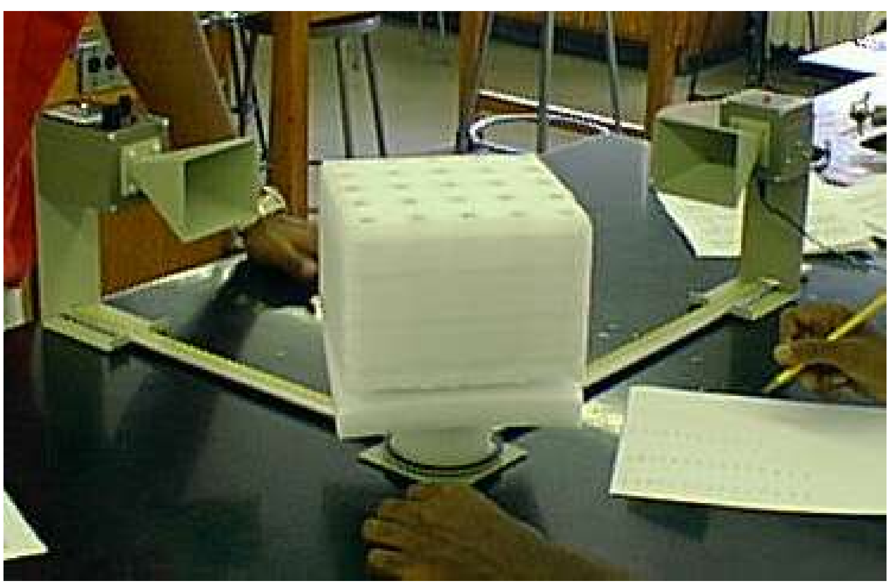


Figure 1: Experimental Set-up



Photograph of Experimental Setup

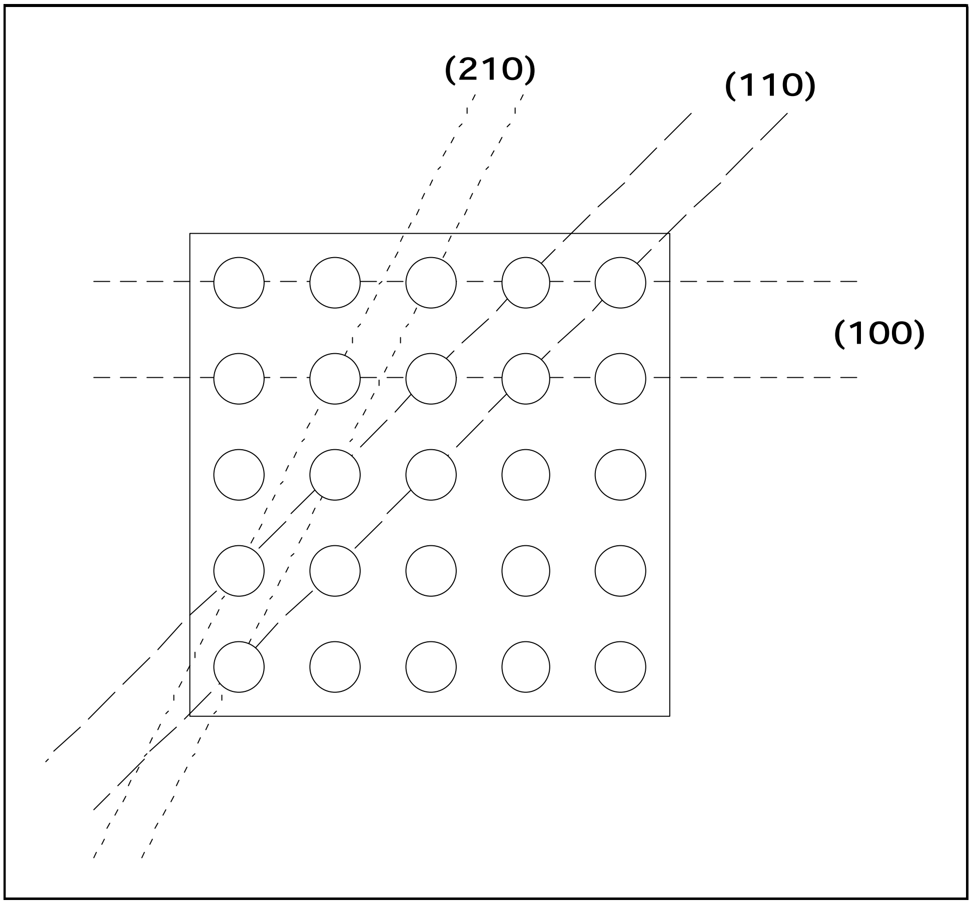


Figure 2: Definition of Families of planes.

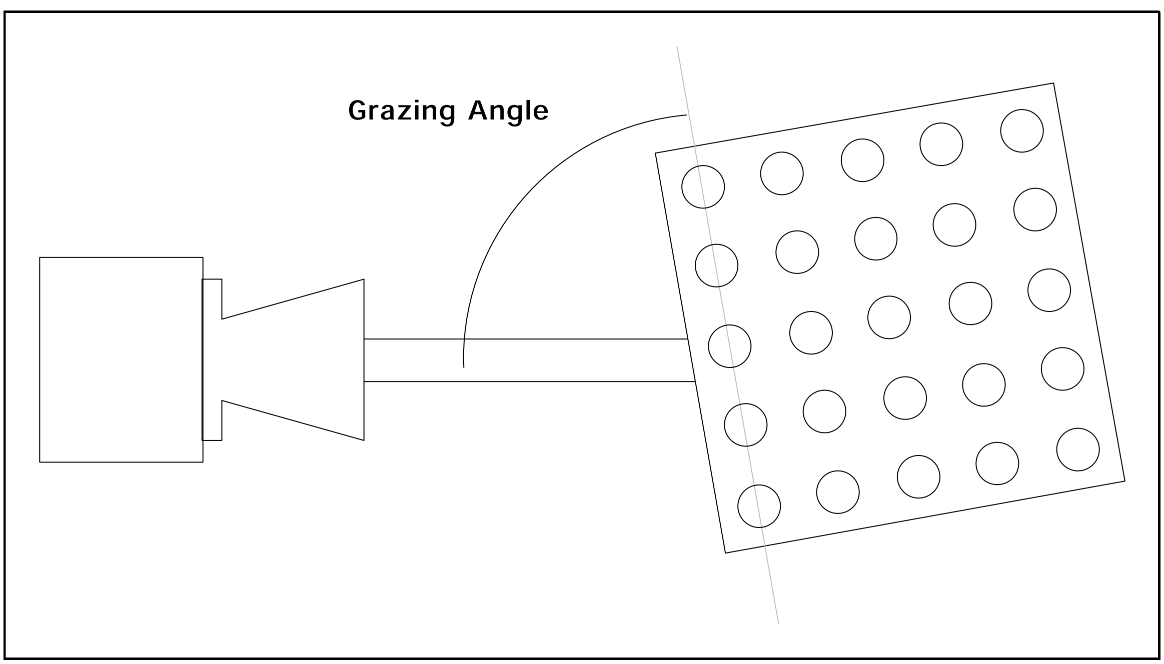


Figure 3: The Grazing angle, measured with respect to the crystal plane for (100) orientation.