Consider the wavefront BOD perpendicular to the two reflected rays. Constructive interference from atoms in successive planes only occurs if the reflected rays have the same phase at the points B and D. Notice that the paths BOD and BOA are equal in length. With d the distance between the Bragg planes, the path difference ACD becomes:

$$AC = OC\sin\theta = d\sin\theta$$

$$CD = OC\sin\theta = d\sin\theta$$

$$ACD = AC + CD = 2d\sin\theta$$

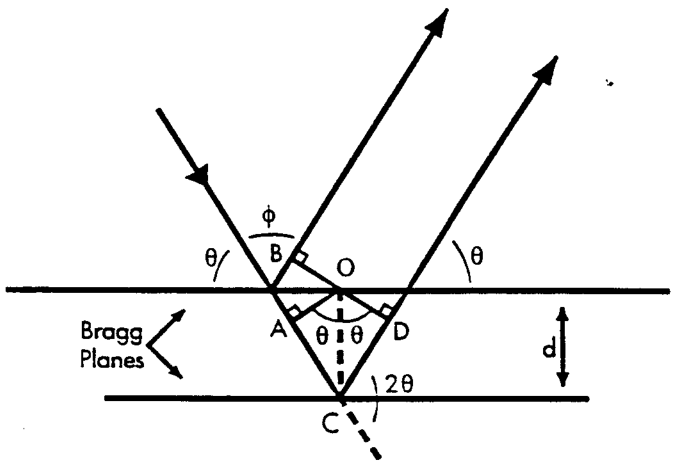

Fig 2: Bragg equation for diffraction

The points B and D have the same phase when the path difference is equal to an integral number of wavelengths. The direction of constructive interference will be given by the angle θ. Hence the condition for constructive interference or diffraction maxima is:

$$n\lambda = 2d\sin\theta$$

where $n=1,2,3,\ldots$ This relationship is known as the Bragg Reflection equation. Take notice that the equation puts an important restriction on the wavelength and atomic spacing.

In this experiment, the foam cube is the simulated crystal. The steel balls act as diffraction centers for the microwaves in much the same way that atoms diffract x-rays. The signal can be diffracted from either the primary or diagonal planes, AA and BB, respectively, in Fig.1. The diffracted signal is picked up by the receiver and measured with an oscilloscope and/or a multimeter as the cube and receiver arm are stepped through 180°. Quantitative analysis of the data then leads to the verification of the Bragg Reflection equation.

Procedure

1. Secure one of the side arms to the end of the main arm using the extension connector block for stability. The holding screws in the extension block may have to be adjusted to facilitate a proper fit.

2. Attach the movable arm to the center post below the turntable disk, and slide the alignment disk assembly over the center post on the turntable. Ensure that the rail support on the underside of the disk assembly is straddling the main arm. Place the foam hub assembly on the alignment disk with the arrow pointing to 0°.

3. To minimize errant signals from the transmitter side lobes, place the transmitter on the stationary arm 50-60cm from the turntable assembly. Place the receiver on the rotatable arm at about 35cm.

4. Complete the setup as shown in figure 3. Adjust the function generator to produce a 4kHz square wave with minimal gain. The oscilloscope should be switched to AC with the time per division at about 50μs. The voltage per division should be set at 50mV and adjusted as necessary. If also using a digital multimeter, set it to 2VAC. Verify that the multimeter is capable of measuring an AC signal at 4kHz.

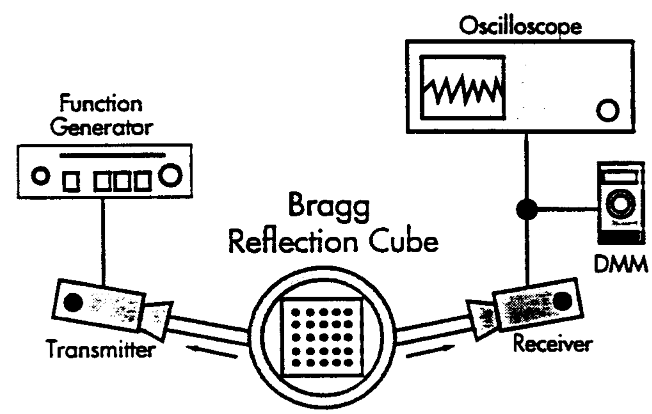

Fig 3: Transmission of waves from Bragg Reflection Cube

5. Set the Bragg Cube in the foam positioner so the side of the cube is perpendicular to the incoming microwaves. Move the receiver arm to 180° and turn the gain on the receiver to its maximum setting. Turn on the transmitter. At this point you should see a waveform on the oscilloscope. If not, adjust the oscilloscope settings so that an entire period is visible. Vary the frequency of the function generator to maximize the waveform. Next, adjust the gain on the function generator until the signal begins to