PHYS 3650L - Modern Physics Laboratory

Laboratory Advanced Sheet
Bragg Diffraction

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1. Objectives. The objectives of this laboratory are

a. to understand the principles behind Bragg diffraction technique, and

b. to determine the wavelength of the probing radiation.

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2. Theory.

a. In a regular atomic crystal, planes of atoms are layered on top of each other, separated by a distance *d*. Not all of the radiation is reflected by the upper plane, but much of it passes through to the next plane, where some percentage of the radiation is reflected back according to the law of specular reflection: the angle of incidence is equal to the angle of reflection. The reflected waves from the adjacent planes will have some path difference, Δ, which depends on the interplanar distance *d* and the angle of incidence θ_i. Geometrically:

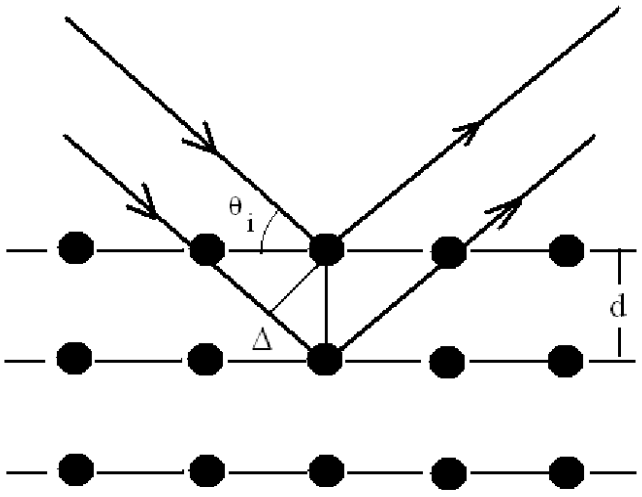

Figure 1. Bragg diffraction.

$$\Delta = 2d \sin\theta_i \qquad \textbf{(1)}$$

b. If the path difference is equal to the integral number of wavelengths, n = ±1, ±2, ±3, ..., then the reflected radiation will interfere constructively, and a peak in the intensity of the reflected radiation will be observed. Hence the Bragg's equation for the maxima in the intensity of the light reflected off of an atomic crystal is given by

$$\Delta = n\lambda = 2d \sin\theta_i \qquad \textbf{(2)}$$

where λ is the wavelength of the probing radiation.

Using the measured value of separation distance *d* and the measured values of the angles of incidence for Braggs peaks, the wavelength of the probing radiation, λ, can be calculated (objective 1b).

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3. Apparatus and experimental procedures.

a. Equipment.

1) Cubic lattice with 100 metal spheres.

2) Goniometer.

3) Microwave transmitter.

4) Microwave receiver.

5) Rotating table.

6) Multimeter.

7) Ruler.

b. Experimental setup. To be provided by the student.

c. Capabilities. To be provided by the student.

d. Procedures. Detailed instructions are provided in paragraph 4 below.

4. Requirements.

a. In the laboratory.

1) Your instructor will introduce you to the equipment to be used in the experiment.

2) Measure the spacing between the spheres.

3) Measure the amplitudes of the incoming signal for various angles of the incoming radiation.

4) Your instructor will discuss methods to be used to prepare your data for plotting using the Microsoft Excel™ spreadsheet program.

b. After the laboratory. The items listed below will be turned in at the beginning of the next laboratory period. A complete laboratory report is **not** required for this experiment.

Para 3. Apparatus and experimental procedures.

1) Provide a figure of the experimental apparatus (para 3b).

2) Provide descriptions of the capabilities of equipment used in the experiment (para 3c).

Para 4. Data. Data tables are included at Annex A for recording measurements taken in the laboratory. A copy of these tables must be included with the lab report. Provide the items listed below in your report in the form a Microsoft Excel™ spreadsheet showing data, calculations and graphs. The spreadsheet will include:

1) Measured spacing between metal spheres.

2) A table with columns for angle of incidence and observed amplitude of the scattered signal.

3) A graph of the signal amplitude versus angle of incidence.

4) Calculation of the wavelength of the probing radiation based on the experimental values of Bragg maxima.

5) Calculation of the percent discrepancies in the wavelength. Your instructor will provide the actual value.

Para 5. Results and Conclusions.

5. Results and Conclusions.

a. Results.

1) A statement of the measured value for the wavelength of the probing radiation.

2) A statement of the calculated percent discrepancy in the wavelength of the probing radiation.

b. Conclusions.

1) Assess the accuracy of your experiment.

2) Describe the sources of error in the experiment.

Annex A
Data

1. Spacing between the spheres.

d = _____ cm

2. Bragg peaks.

Angle of incidence (degrees)	Amplitude of the signal (V)	Angle of incidence (degrees)	Amplitude of the signal (V)
0^o		26^o	
1^o		27^o	
2^o		28^o	
3^o		29^o	
4^o		30^o	

5^o		31^o	
6^o		32^o	
7^o		33^o	
8^o		34^o	
9^o		35^o	
10^o		36^o	
11^o		37^o	
12^o		38^o	
13^o		39^o	
14^o		40^o	
15^o		41^o	
16^o		42^o	
17^o		43^o	
18^o		44^o	
19^o		45^o	
20^o		46^o	
21^o		47^o	
22^o		48^o	
23^o		49^o	
24^o		50^o	
25^o		51^o	