The structures of crystals and molecules are often being identified using x-ray diffraction studies, which are explained by Bragg’s Law. The law explains the relationship between an x-ray light shooting into and its reflection off from crystal surface.

### Introduction

Bragg’s Law was introduced by Sir W.H. Bragg and his son Sir W.L. Bragg. The law states that when the x-ray is incident onto a **crystal** surface, its angle of incidence, $\theta$, will reflect back with a same angle of scattering, $\theta$. And, when the path difference, $d$, is equal to a whole number, $n$, of wavelength, a constructive interference will occur.

Consider a single crystal with aligned planes of lattice points separated by a distance $d$. Monochromatic X-rays A, B, and C are incident upon the crystal at an angle $\theta$. They reflect off atoms X, Y, or Z.

![Diagram of X-ray diffraction](image.png)

The path difference between the ray reflected at atom X and the ray reflected at atom Y can be seen to be $2YX$. From the Law of Sines we can express this distance $YX$ in terms of the lattice distance and the **X-ray incident angle**:

If the path difference is equal to an integer multiple of the wavelength, then X-rays A and B (and by extension C) will arrive at atom X in the same phase. In other words, given the following conditions:

then the scattered radiation will undergo constructive interference and thus the crystal will appear to have reflected the X-radiation. If, however, this condition is not satisfied, then destructive interference will occur.

### Bragg’s Law

\[ n\lambda = 2d\sin\theta \]

where:

- $\lambda$ is the wavelength of the x-ray,
- $d$ is the spacing of the crystal layers (path difference),
- $\theta$ is the incident angle (the angle between incident ray and the scatter plane), and
- $n$ is an integer
The principle of Bragg’s law is applied in the construction of instruments such as Bragg spectrometer, which is often used to study the structure of crystals and molecules.

References