Bragg Formulation of X-ray Diffraction by a Crystal – Bragg's Reflection

Abstract

The experiment determines the **path difference in accordance with Bragg's law**. X-ray diffraction provides fundamental understanding of how crystalline structures interact with incident x-rays leading to constructive interference. Interatomic distance in a solid are of the order of an angstrom and therefore, whatever probe (i.e., electromagnetic wave) must have a wavelength on the order of interatomic distance, characteristic to x-rays.

In crystalline materials, for certain wavelengths and incident directions, intense peaks of scattered radiation (Bragg peaks) were observed. According to Bragg's law, in order for the observed peaks to form, the x-rays reflected by the lattice planes must interfere constructively, which happens when the path difference between rays specularly reflected (angle of incidence equals the angle of reflection) from adjoining planes is an integer number of wavelengths.

The required experiment is provided in **Apps on Physics**, under solid state physics. Open the App, **Bragg Reflection**. The app shows a virtual interface of lattice planes and incident x-rays. Variable values within certain limits can be entered such as the interplanar distance, wavelength, glancing angle and, number of lattice planes.

The **Bragg's law equation** (given below) is used for calculations, yielding the path difference.

$$\Delta s = 2\, d \sin \theta = k\, \lambda$$

Δs = path difference (for neighbouring rays)
d = interplanar distance
θ = glancing angle (between ray and lattice plane)
k = order of diffraction (1, 2, 3, ...)
λ = wavelength

A given unknown crystal has many planes of atoms in its structure, therefore the collections of reflections of all the planes can be used to uniquely identify an unknown crystal. Examples from standard textbooks (mentioned under references) can be used to explain the concept. Using the available input data path difference can be found.