Solid state

Diffraction of X-rays by Crystals

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A scattering of X-rays by the atoms of a crystal that produces an interference effect so that the diffraction pattern gives information on the structure of the crystal or the identity of a crystalline substance. X-ray diffraction is based on constructive interference of monochromatic X-rays and a crystalline sample. These X-rays are generated by a cathode ray tube, filtered to produced monochromatic radiation, collimated to concentrate and directed towards the sample

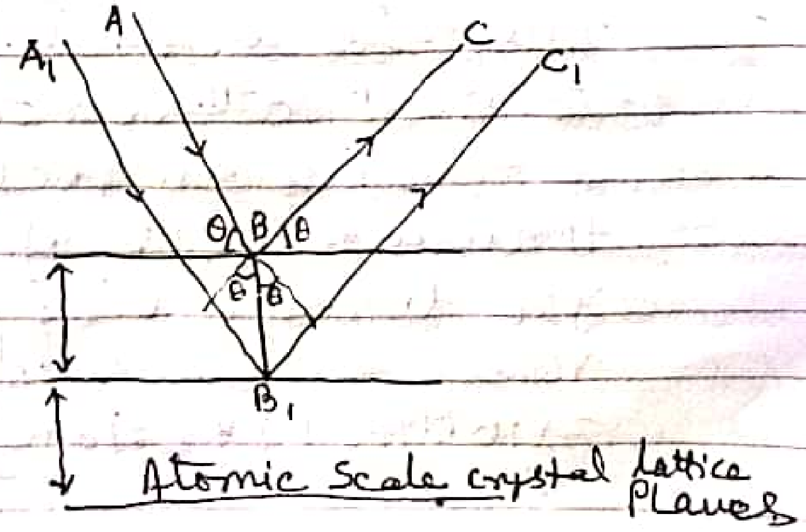


Fig-I

A scattering of x-rays by the atoms of a crystal that produces an interference effect so that the diffraction pattern gives information on the structure of the crystal or the identity of a crystalline substance.

Introduction of X-rays:-

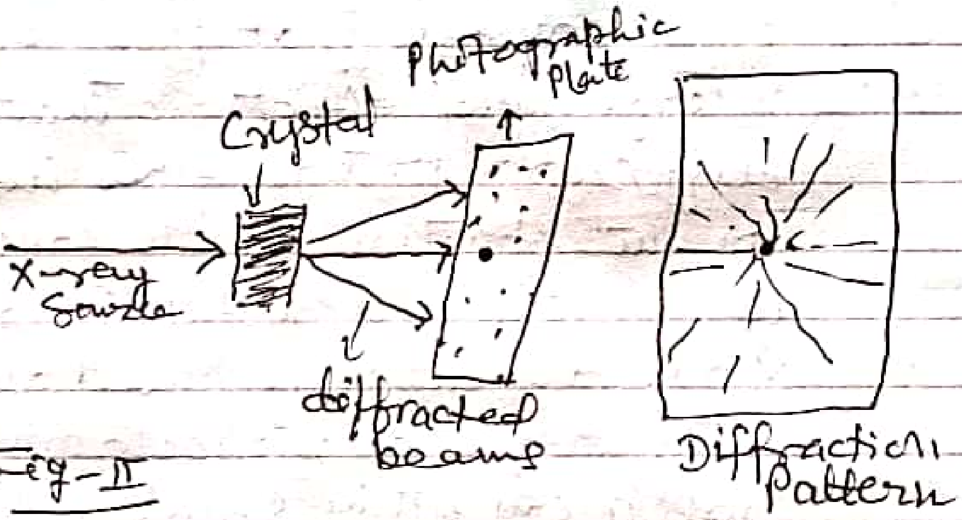


Fig-II

X-ray, invisible, highly penetrating electromagnetic radiation of much shorter wavelength (higher frequency) than visible light. The wavelength range for x-rays is from about 10^{-8}m to about 10^{-11}m, or from less than a billion of an inch to less than a trillionth of an inch. The corresponding frequency range is from 3×10^{16} Hz to about 3×10^{19} Hz (1 Hz = 1 cps) a reflection spot in the diffraction pattern. Crystals are regular arrays of atoms and x-rays can be considered electromagnetic radiation. A regular array of scatterers produces a regular array of spherical waves. Although these waves cancel one another out in most directions through destructive interference they add constructively in a few specific directions determined by Bragg's Law

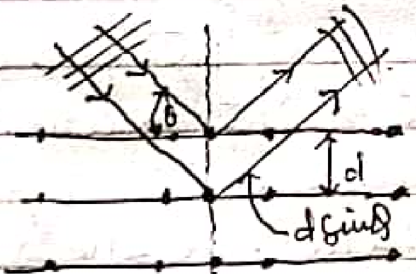
$$2d \sin\theta = n\lambda$$

Here d is the spacing between diffracting planes, θ is the incident angle, n is any integer and λ is the wavelength of the beam. These specific directions appear as spots on the diffraction pattern called reflections. Thus x-ray diffraction results from an electromagnetic wave (x-ray) impinging on a regular array of scatterers. X-rays are used to produce the diffraction pattern because their wavelength λ is typically the same order of magnitude (1-100 angstrom) as the spacing d between planes in the crystal.

History of X-rays Crystallography →

The study of atomic structure of crystals by X-rays was initiated in 1914 by W. H. Bragg and W. L. Bragg with remarkable achievements. They found that a monochromatic beam of X-rays was reflected from a crystal plane as if it is acted like mirror.

X-ray diffraction



The incoming beam coming from upper left causes each scatterer to reradiate a small portion of its intensity as a spherical wave. If scatterers are arranged symmetrically with a seperation d, These spherical waves will be in sync only in directions where their path length difference 2d sinθ equals an integer multiple of wavelength λ. In that case part of the incoming beam is deflected by an angle 2θ, producing