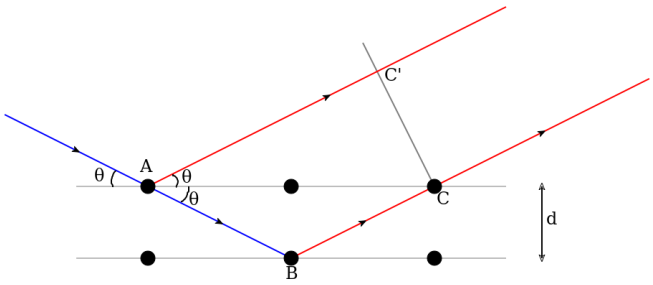
Question: State Bragg Law. What assumptions were made while deriving Bragg equation?



Answer:

Bragg diffraction occurs when electromagnetic radiation or waves with wavelength comparable to atomic spacings are incident upon a crystalline sample and are scattered in a specular fashion by the atoms in the system, and undergo constructive interference. For a crystalline solid, the waves are scattered from lattice planes separated by the interplanar distance ***d***. Where the scattered waves interfere constructively, they remain in phase since the path length of each wave is equal to an integer multiple of the wavelength.

Suppose that a single monochromatic wave (of any type) is incident on aligned planes of lattice points, with separation d, at angle θ. Points **A** and **C** are on one plane, and **B** is on the plane below. Points **ABCC'** form a quadrilateral. There will be a path difference between the ray that gets reflected along **AC'** and the ray that gets transmitted, then reflected, along **AB** and **BC** respectively. This path difference is $(AB + BC) - (AC')$.

The two separate waves will arrive at a point with the same phase, and hence undergo constructive interference, if and only if this path difference is equal to any integer value of the wavelength, i.e.

$$(AB + BC) - (AC') = n\lambda,$$

where the same definition of $n$and λ apply as above.

Therefore, $AB = BC = \dfrac{d}{\sin\theta}$and $AC = \dfrac{2d}{\tan\theta}$,

from which it follows that

$$AC' = AC \cdot \cos\theta = \frac{2d}{\tan\theta}\cos\theta = \left(\frac{2d}{\sin\theta}\cos\theta\right)\cos\theta = \frac{2d}{\sin\theta}\cos^2\theta.$$

Putting everything together, $n\lambda = \dfrac{2d}{\sin\theta}(1 - \cos^2\theta) = \dfrac{2d}{\sin\theta}\sin^2\theta,$ which simplifies to $n\lambda = 2d\sin\theta,$ which is Bragg's law.

Assumptions:

1) Falling light is a single monochromatic wave

2) If only two planes of atoms were diffracting, then the transition from constructive to destructive interference would be gradual as the angle is varied.

3) Grating is periodic