Explain Reciprocal Lattice. obtain Bragg's equation in terms of reciprocal lattice.

Reciprocal Lattice:-

In a crystal lattice there exist many sets of planes, with different orientations and spacings, which can cause diffraction as shown in fig-①.

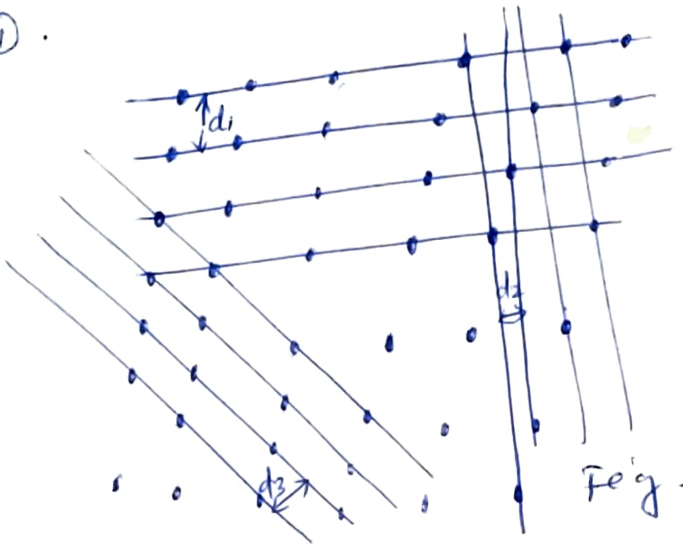

Fig-①

If we draw, from a common origin, normals to all sets of planes, the length of each normal being proportional to the reciprocal of the interplanar spacing of the corresponding set, then the end-points of the normals form a lattice which is called the 'reciprocal lattice'. Each point in the reciprocal lattice preserves the characteristics of the set of planes which it represents. Its direction with respect to the origin represents the orientation of the planes, and its distance from the origin represents the interplanar spacing of the planes.

Bragg's equation:-

crystal structure is explored through the diffraction of waves having a wavelength comparable with the interatomic spacing (10^{-10} m) in crystals. Radiation of longer wavelength cannot resolve the details of structure, while radiation of much shorter wavelength is diffracted through inconveniently small angles. Usually, diffraction of X-rays, neutrons and less often, electrons is employed in the study of crystal structure.

W. L. Bragg presented an explanation of the observed diffracted beams from a crystal.

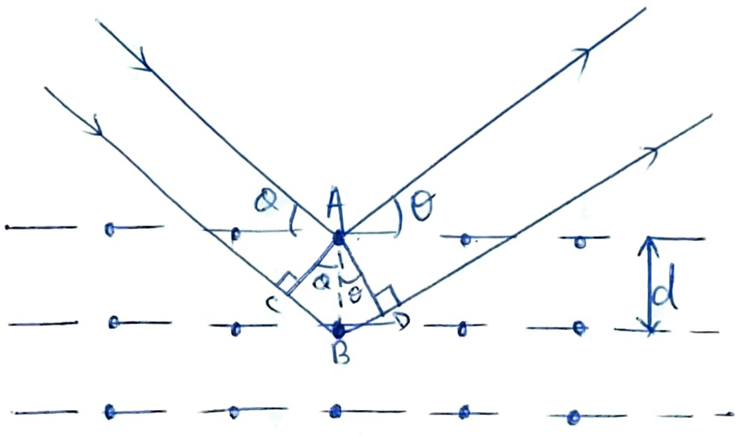

fig - 2

In fig - 2, shown a particular set of atomic planes in a crystal, d being the interplanar spacing. Suppose an X-ray beam is incident at a glancing angle θ. It is scattered by the atoms like A and B in random directions. Constructive interference takes place only between those

Scattered waves which are reflected specularly and have a path difference of $n\lambda$, where λ is the X-ray wavelength and n is an integer.

The path difference for the waves reflected from adjacent planes is

$$CB + BD = d\sin\theta + d\sin\theta$$
$$= 2d\sin\theta.$$

For constructive interference, we must have

$$\boxed{2d\sin\theta = n\lambda} \quad \text{——— (1)}$$

where, $n = 1, 2, 3, \ldots$

This is Bragg's equation. It shows that for given value of λ and d only for certain values of θ (corresponding to $n = 1, 2, 3, \ldots$), the reflected waves add up in phase to give a strong reflected beam.

The Bragg's law is a consequence of the periodicity of the space lattice. The arrangement of atoms associated with each lattice point determines the relative intensity of the various order n of diffraction from a given set of parallel planes.