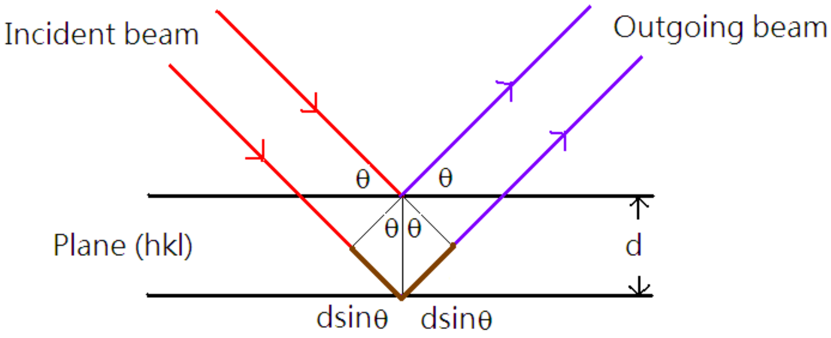
VII Bragg's law

7-1、Bragg's law



When the total path difference $2d\sin\theta$ equals to $n\lambda$, diffraction occurs.

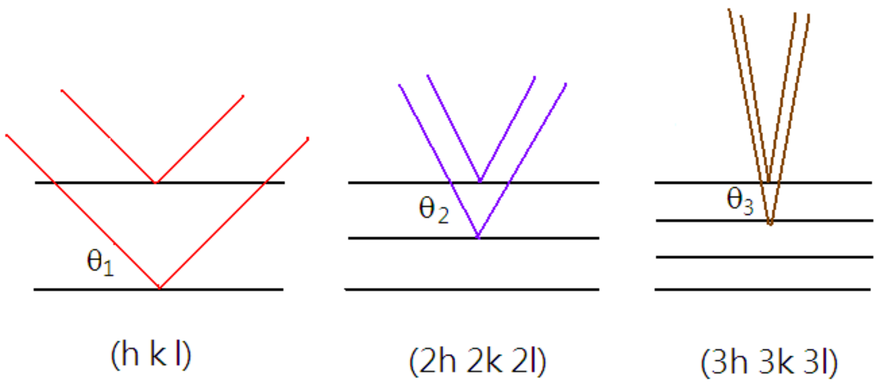
The Bragg's law is expressed as

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

, where n is the order of reflection

The Bragg's equation can be rewritten as

$$2\frac{d}{n}\sin\theta = \lambda$$

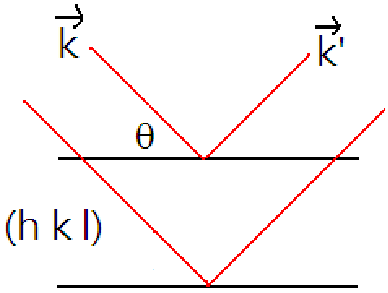


, where $\theta_1 < \theta_2 < \theta_3$

Therefore, the $2d\sin\theta = n\lambda$ can be rewritten as

$$2d_{hkl}\sin\theta = \lambda$$

7-2、Ewald sphere construction



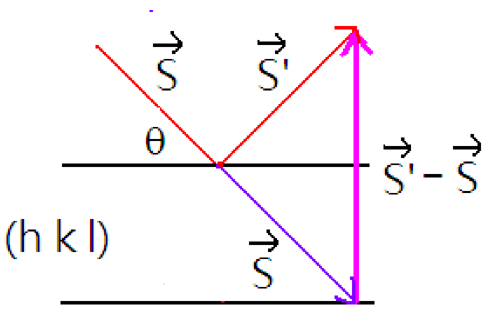
Where $\vec{\kappa}$ is the wave number of the incident beam and $\vec{\kappa}'$ is the wave number of the outgoing beam.

$$\kappa = |\vec{\kappa}| = \frac{2\pi}{\lambda}$$
$$\kappa = |\vec{\kappa}'| = \frac{2\pi}{\lambda}$$

We define

$$\vec{S} = \frac{\vec{\kappa}}{2\pi}$$
$$\vec{S}' = \frac{\vec{\kappa}'}{2\pi}$$

Then



$$\vec{S}' - \vec{S} = \vec{G}^{*}_{hkl}$$

Proof:

(i)

$$|\vec{S}' - \vec{S}| = 2|\vec{S}|\sin\theta$$

$$\left|\vec{S}' - \vec{S}\right| = 2\frac{\kappa}{2\pi}\sin\theta = 2\frac{2\pi}{2\pi\lambda}\sin\theta = 2\frac{\sin\theta}{\lambda}$$

Note that

$$2d_{hkl}\sin\theta = \lambda$$
$$\left|\vec{S}' - \vec{S}\right| = \frac{1}{d_{hkl}}$$
$$\left|\vec{S}' - \vec{S}\right| = \left|\vec{G}^*_{hkl}\right|$$

(ii) $\vec{S}' - \vec{S}$ is parallel to (h,k,l) plane normal

$\vec{S}' - \vec{S}$ is parallel to $\vec{G}^*_{hkl}$

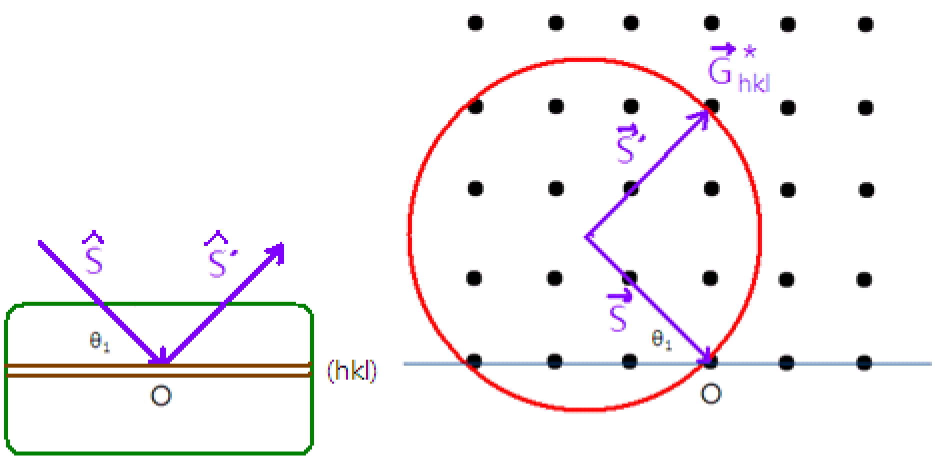
Therefore

$$\vec{S}' - \vec{S} = \vec{G}^*_{hkl}$$

This is equivalent to

$$\vec{\kappa}' - \vec{\kappa} = 2\pi\vec{G}^*_{hkl}$$

7-3、 Ewald sphere



The reciprocal lattice is derived from the crystal structure.

Diffraction occurs at

$$\vec{S}' - \vec{S} = \vec{G}^*_{hkl}$$

Remark：

(i) $\vec{\kappa}' - \vec{\kappa}$ relates to the arrangement of "wave"

(ii) $\vec{G}^*_{hkl}$ relates to the arrangement of "object"

When $\vec{\kappa}' - \vec{\kappa} = 2\pi\vec{G}^*_{hkl}$, diffraction from the plane (hkl) occurs.