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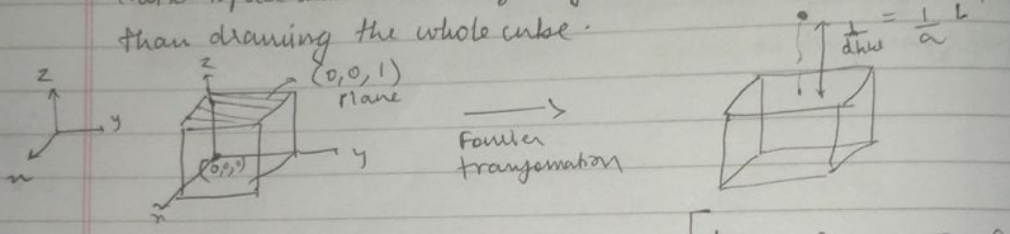
2020UMT0175
@modi

Mid-sem Exam

1. Mathematical property – Periodic function $f(x)$
where $f(x) = f(x+\delta)$ δ - Periodicity

The effect will be converting a real lattice to reciprocal lattice space which is imaginary but easier to differ rather than drawing the whole cube.

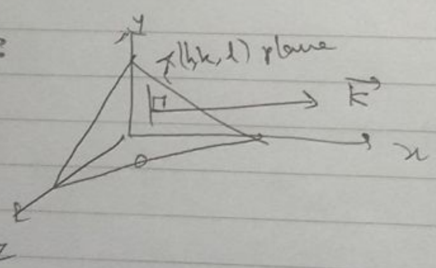


$$d = \frac{a}{\sqrt{h^2+k^2+l^2}} = \frac{a}{\sqrt{0+0+1}} = a$$

Hence the plane can be denoted by a point depending on frequency. which is at a length $\frac{1}{d_{hkl} \text{ (interplanar spacing)}}$ from the plane having unit length inverse.

To Prove: $\vec{k} \perp$ to the diffracting plane tilted —(i)
Let us consider.

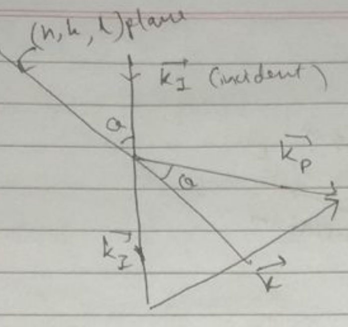
To prove:



If vectors were given:
∴ We can $s = (ha + kb + lc)$ is the plane
$\vec{k} = ha' + kb' + lc'$

∴ We ~~need~~ could ~~to~~ prove by letting
$\vec{r}$ be $\perp$ to the plane and $\vec{k} \times \vec{r} = 0$
since they both should be parallel.

1) $\longrightarrow$ continued



$\therefore \vec{k} + \vec{k_I} = \vec{k_0}$ $|\vec{k_I}| = \frac{1}{\lambda}$ $|\vec{k_0}| = \frac{1}{\lambda}$

Since $\vec{k_I}$ and $\vec{k_p}$ magnitude equal

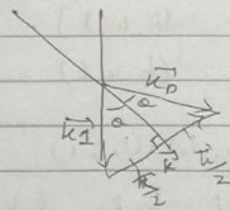
$\vec{k}$, $\vec{k_0}$ & $\vec{k_I}$ forms an isosceles Δ

we know by ~~By geometry,~~ Braggs law,

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

we also know that $|\vec{k}| = \frac{1}{d_{hkl}}$

If we assume $\vec{k} \perp$ to (h,k,l) plane,



since isosceles Δ,
$\vec{k}$ its divided into two parts

$\therefore |\frac{\vec{k}}{2}| = 2|\vec{k_I}|\sin\theta$

$\therefore |\vec{k}| = 2|\vec{k_I}|\sin\theta$

~~So to p~~

So now our problem has come to prove:

$|\vec{k}| = 2|\vec{k_I}|\sin\theta$ — (ii)

L.H.S

~~$|\vec{k}| = \frac{1}{2d_{hkl}\sin\theta}$~~ $|\vec{k}| = \frac{1}{d_{hkl}}$

1) R.H.S

$2|\vec{k_i}|\sin\theta$

$= 2 \frac{1}{\lambda} \sin\theta$

From bragg's law,

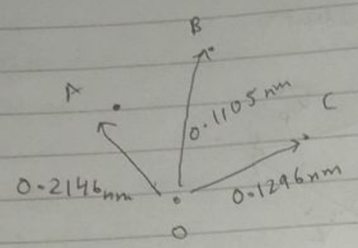
$= \cancel{2} \times \frac{1}{\cancel{2} d_{(hkl)} \cancel{\sin\theta}} \cancel{\sin\theta}$

$= \frac{1}{d_{hkl}}$

$\therefore$ L.H.S = R.H.S

$\therefore$ Hence (i) is proved hence (ii) is proved.

2.



$\because |\vec{K}| = |\vec{OA}| = \frac{1}{d_{hkl}}$

$\therefore d_{hkl_A} = \frac{1}{|\vec{OA}|} = 4.6598\ nm^{-1}$

$d_{hkl_B} = \frac{1}{|\vec{OB}|} = 9.0497\ nm^{-1}$

$d_{hkl_C} = \frac{1}{|\vec{OC}|} = \cancel{4.6598}\ 7.71604\ nm^{-1}$

From the info set,

For ~~point A~~, d_{hkl_A}, $(h,k,l) = (1,1,1)$

d_{hkl_B} $(h,k,l) = (1,1,3)$

d_{hkl_C} $(h,k,l) = (0,2,2)$

Taking A & C, $(h_1,k_1,l_1) = (1,1,1)$ $(h_2,k_2,l_2) = (0,2,2)$

Using formula, $[k_1l_2 - k_2l_1,\ l_1h_2 - l_2h_1,\ h_1k_2 - h_2k_1]$

$= [(1\times2)-(2\times1),\ (1\times0)-(2\times1),\ (1\times2)-(0\times1)]$

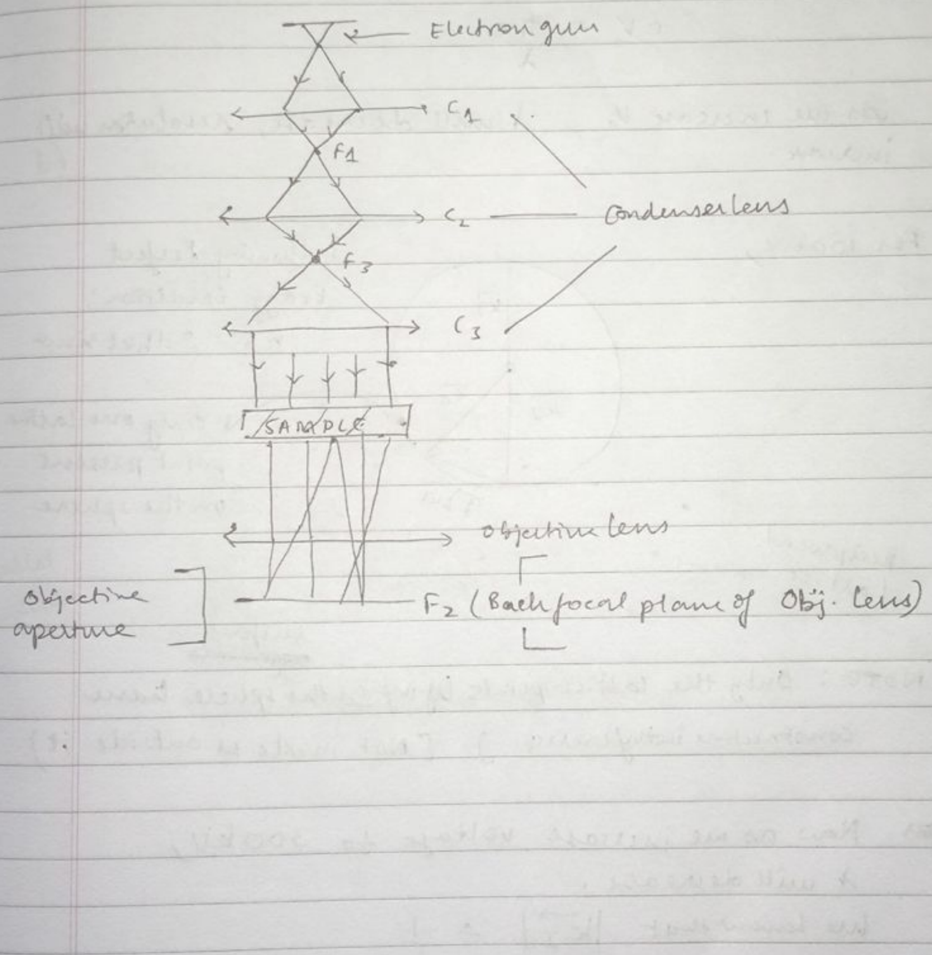
zone axis of Alignment $= [0, \bar{2}, 2]$

Includes this or family of $\langle 0,\bar{2},2\rangle$

2) continued

Schematic Ray Diagram

The back focal plane is the place of the Objective lens this DP will be formed.



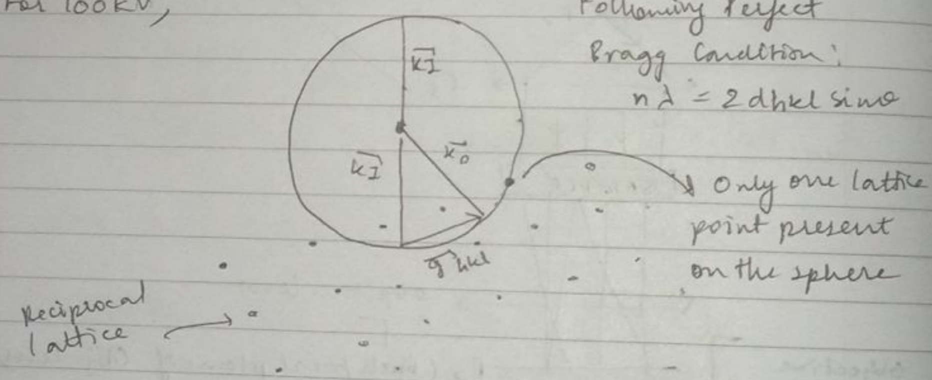
3 a) Since we increased the voltage from 100kV to 300kV,
we know $E = \frac{hc}{\lambda}$

where Energy $E = eV_0$ voltage.

$$\therefore eV_0 = \frac{hc}{\lambda}$$

As we increase V_0, λ will decrease, resolution will increase.

For 100kV,



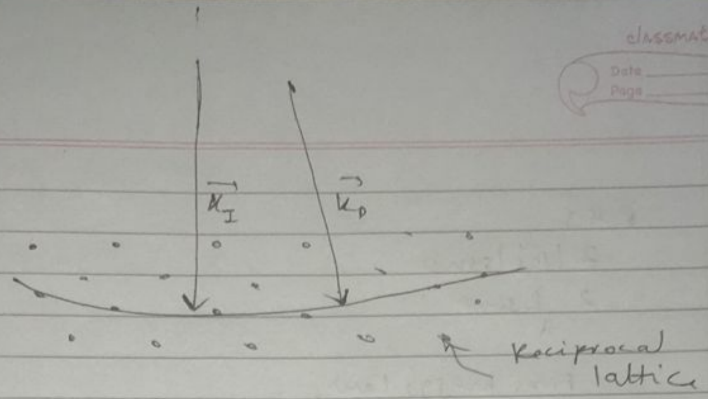
Following Perfect Bragg Condition:
$n\lambda = 2d_{hkl}\sin\theta$

[NOTE: Only the lattice points lying on the ~~parameter~~ surface sphere have constructive interference] [Not inside or outside it]

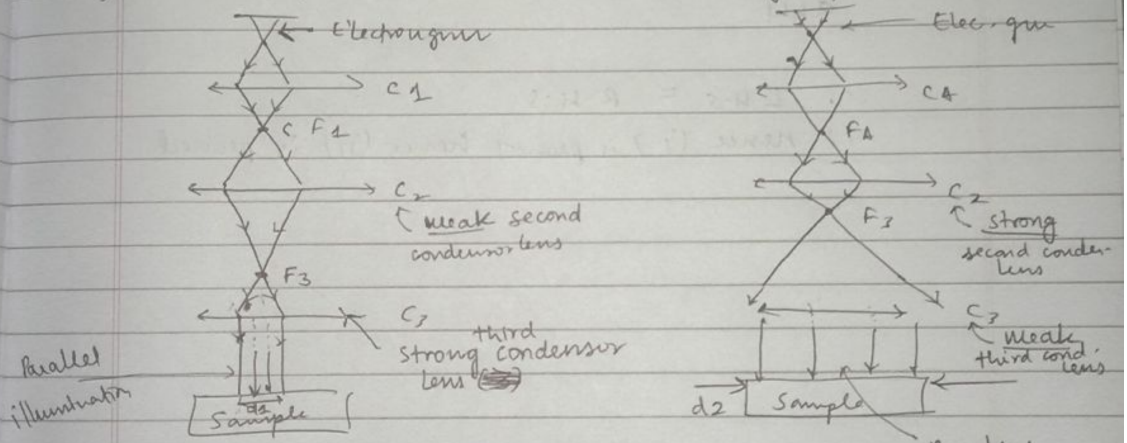
Now as we increase voltage to 300kV,
λ will decrease.
We know that $|\vec{k_I}| = \frac{1}{\lambda}$

And since $\vec{k_I}$ is the radius, As λ decreases $|\vec{k_I}|$ will increase, radius of Ewald Sphere will increase.

3 a)
continued



b) Smaller probe | Larger probe diam.



From the ray diagram,

$d_2 > d_1$