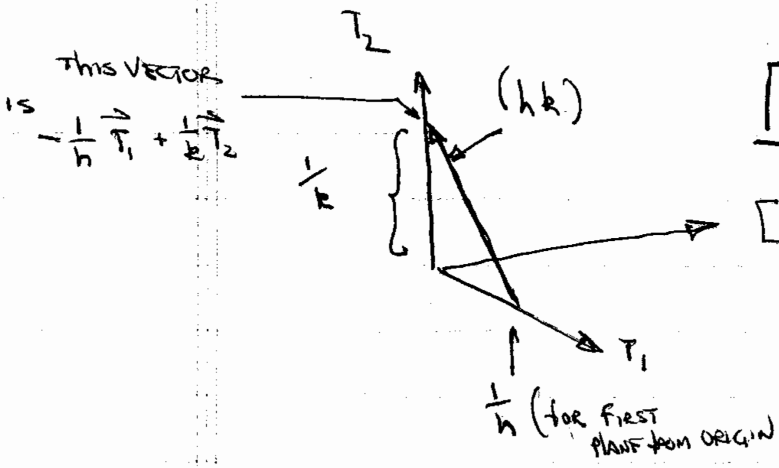


Problem 1

$$[hk] = h\vec{T}_1 + k\vec{T}_2$$

is $[hk] \perp (hk)$?

(a) is the same as asking

is $\left[h\vec{T}_1 + k\vec{T}_2\right] \perp \left[-\frac{1}{h}\vec{T}_1 + \frac{1}{k}\vec{T}_2\right]$?

So $\left[h\vec{T}_1 + k\vec{T}_2\right] \cdot \left[-\frac{1}{h}\vec{T}_1 + \frac{1}{k}\vec{T}_2\right] \stackrel{?}{=} 0$

$$0 \stackrel{?}{=} -\frac{h}{h}\vec{T}_1\cdot\vec{T}_1 + \frac{h}{k}\vec{T}_1\cdot\vec{T}_2 - \frac{k}{h}\vec{T}_2\cdot\vec{T}_1 + \frac{k}{k}\vec{T}_2\cdot\vec{T}_2$$

$$0 \stackrel{?}{=} \underbrace{-|T_1|^2 + |T_2|^2}_{0 \text{ only if } |T_1| = |T_2|} \underbrace{+ \frac{h}{k}\vec{T}_1\cdot\vec{T}_2 - \frac{k}{h}\vec{T}_1\cdot\vec{T}_2}_{0 \text{ only if } \vec{T}\cdot\vec{T}_2 = 0}$$

ie $\vec{T}_1 \perp \vec{T}_2$

$\therefore$ $\boxed{[hk] \text{ is } \perp (hk) \text{ only for square nets}}$

(b) 3-D can be similarly done

find two vectors analagous to the above

$\left[-\frac{1}{h}\vec{T}_1 + \frac{1}{k}\vec{T}_3\right]$ and $\left[-\frac{1}{k}\vec{T}_2 + \frac{1}{\ell}\vec{T}_3\right]$

take their cross product — this is a vector normal to $(hk\ell)$

is cross product proportional to $h\vec{T}_1 + k\vec{T}_2 + \ell\vec{T}_3$?

(only if cubic)

Problem 2

When we derived Braggs' Law we said the path difference must be an integral number of wave lengths.

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

→ n in this formula is an integer greater than or equal to 1. We call it the order of diffraction.

→ But most of us who have used Bragg's Law have never thought about "n". Where did it go? Do we just ignore it?

→ What is done is instead of having to refer to "first order diffraction from (111) planes" and "second order diffraction from (111) planes" we use the following bit of info:

↔ Second order diffraction from (hkl) planes looks like 1st order diffraction from planes spaced half as far, and the indices of this plane will be $(nh, nk\ nl)$ and the spacing will be d_{hkl}/n where $n=2$ in this case

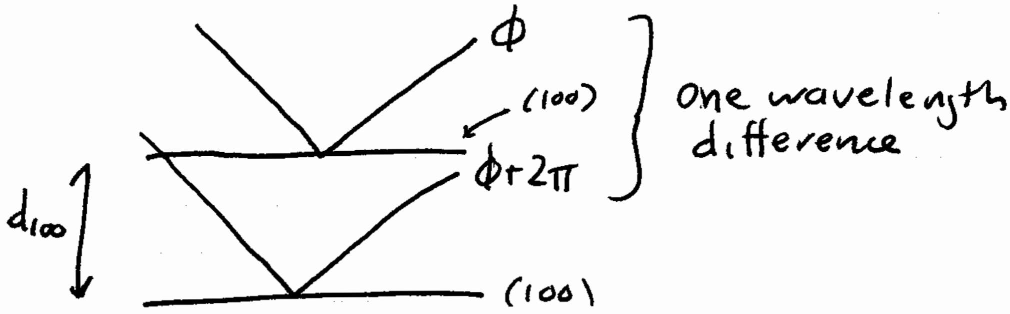
→ Wait! What do you mean? There might not be any atoms on this plane to do the scattering. It doesn't matter, this plane can be fictitious. It just <u>looks</u> like diffraction from these planes.

→ maybe a picture will be helpful...

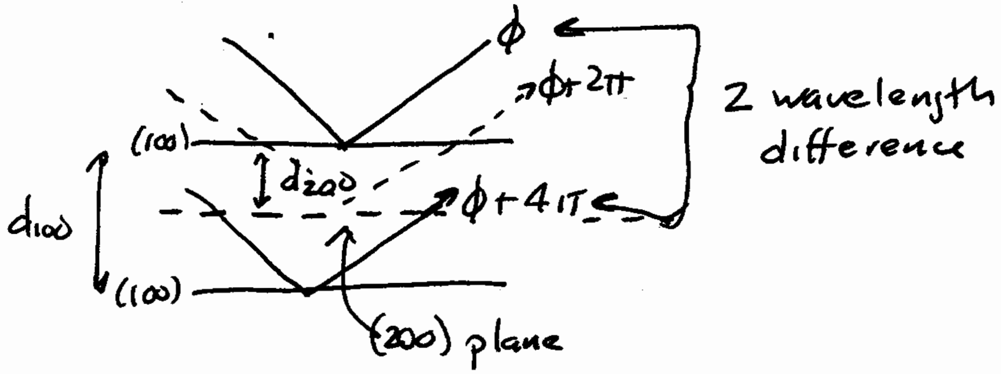
→

Problem 2 con't

first order from (100)



second order from (100)

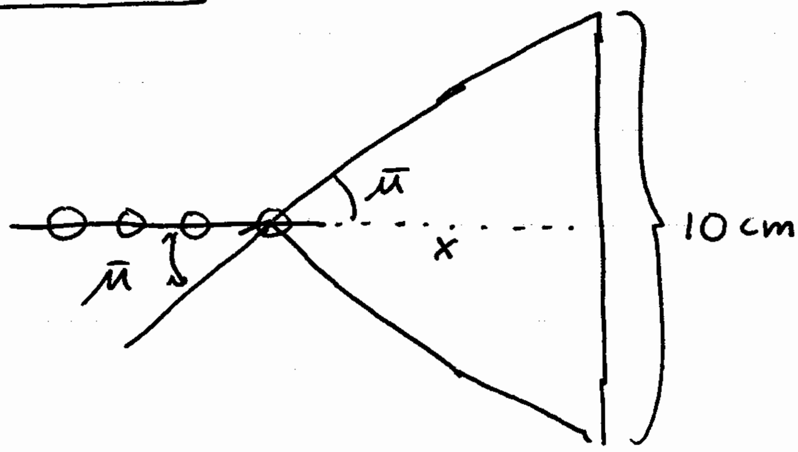


- So second order from (100) looks like first order from (200) planes. (with spacings $d_{200} = \frac{d_{100}}{2}$)

→ So this is why when looking at diffraction patterns you will see peaks indexed with what appears to be unconventional notation ((200), (222), (500))

Problem 3

(a)



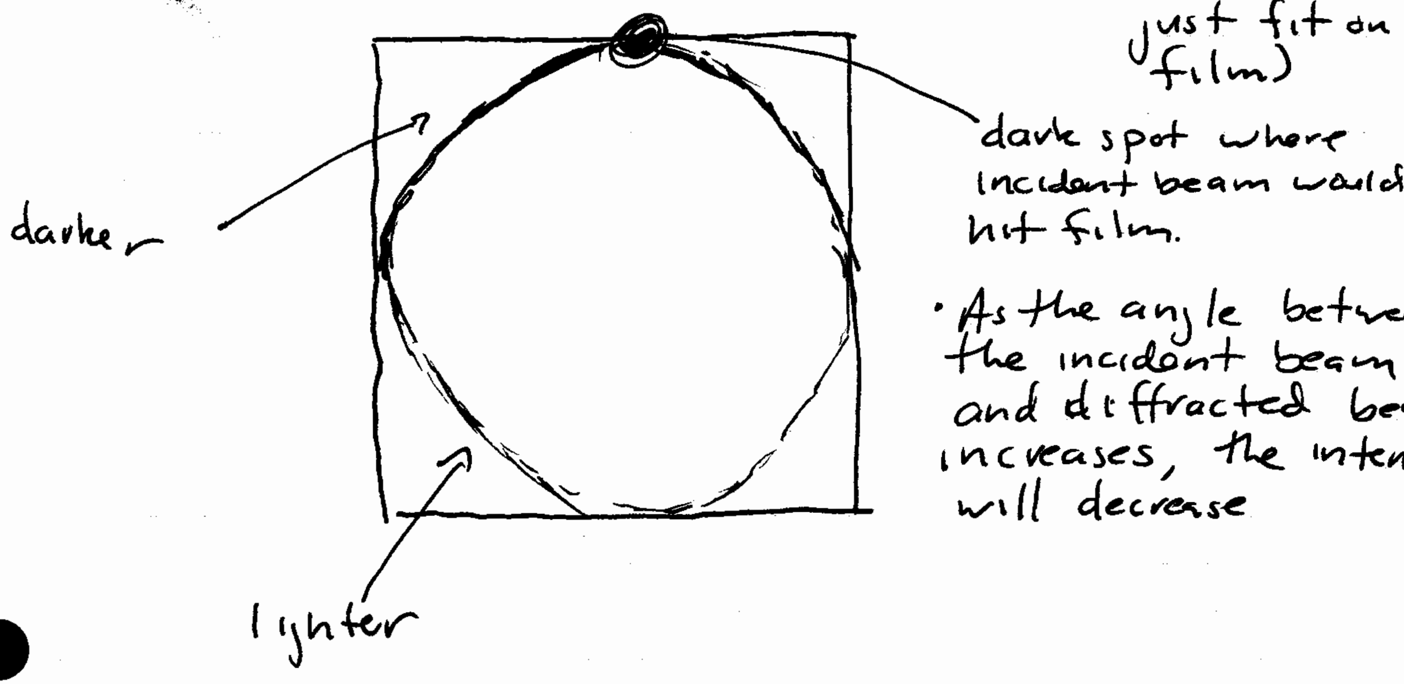
$\bar{\mu} = 52°$

We want the cone to just fit on our film. This just requires a little trig:

$$\tan\bar{\mu} = \frac{5\text{cm}}{x\text{cm}}$$

$$x = 3.9\text{cm}$$

(b) Our film would record a circle: (which would just fit on the film)



• As the angle between the incident beam and diffracted beam increases, the intensity will decrease

Problem 3

(c) In part (a) we looked at only the 0^{th} order diffraction cone since $\bar{\nu} = \bar{\mu}$

$$\cos\bar{\nu} = \frac{m\lambda}{a} + \cos\bar{\mu}$$

$$\text{if } m=0 \longrightarrow \cos\bar{\nu} = \cos\bar{\mu} \Longrightarrow \bar{\mu} = \bar{\nu}$$

Now we have to consider other values of m to see if any other cones would intercept the film.

$m = +1$:
$$\cos\bar{\nu} = \frac{\lambda}{a} + \cos 52°$$

$$\cos\bar{\nu} = \frac{1}{3.5} + \cos 52°$$

$\bar{\nu} = 25.7°$ This would appear on film

$m = -1$:
$$\cos\bar{\nu} = -\frac{1}{3.5} + \cos 52°$$

$\bar{\nu} = 70.7°$ This is greater than the angle for 0^{th} order, so it would miss the film.

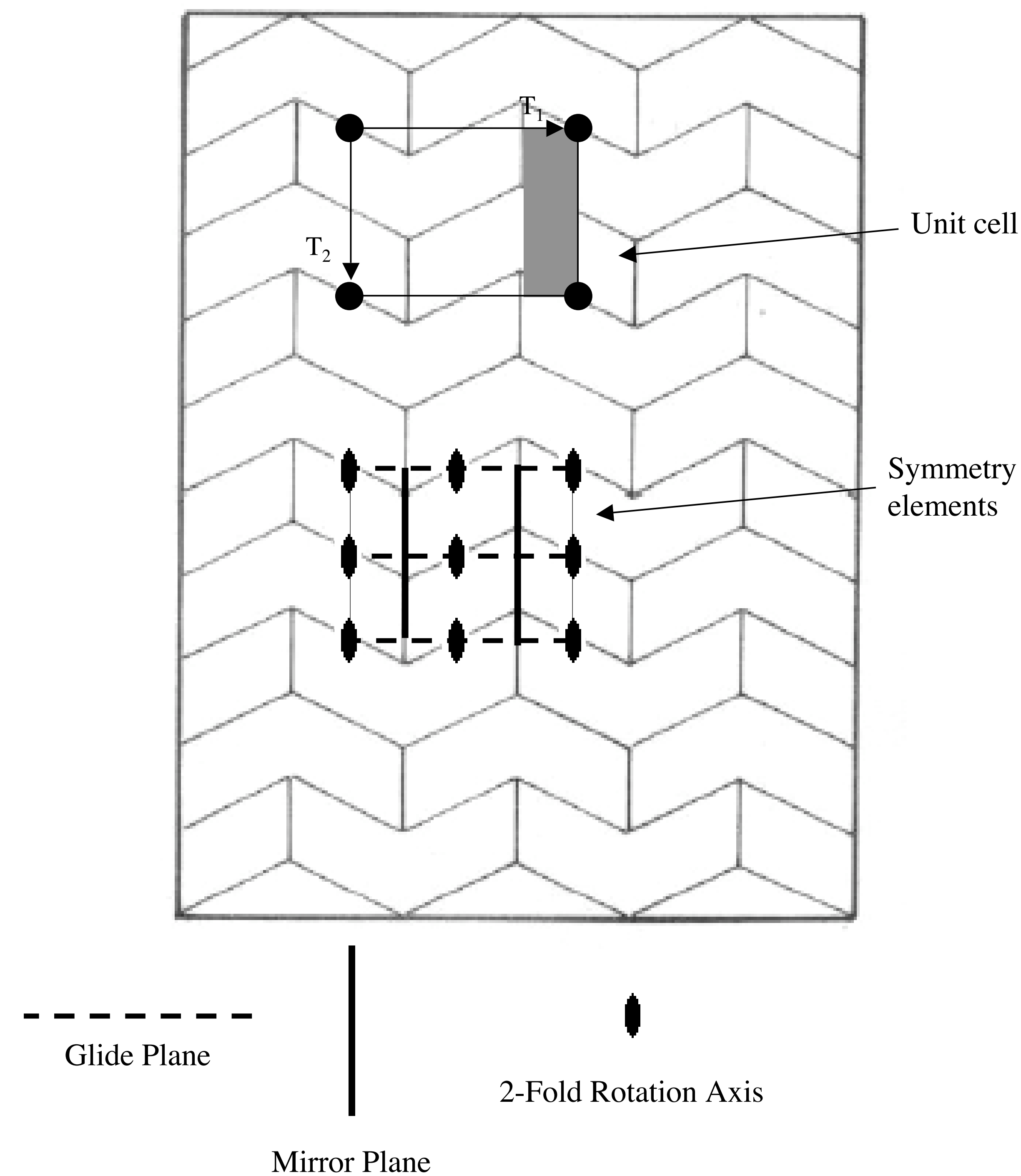
$m = 2$
$$\cos\bar{\nu} = \frac{2}{3.5} + \cos 52°$$

$\cos\bar{\nu} = 1.187 \longrightarrow$ This is impossible

So there would be one other circle for $m = \underline{1}$

Problem 4

Plane Group: p2mg



Problem 4

Plane Group: c2mm