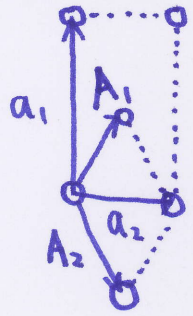
1.



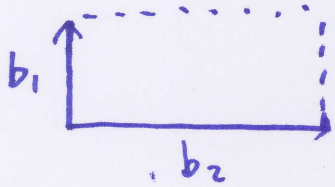
A_1, A_2 forms primitive basis

a_1, a_2 forms non-primitive

primitive means minimal, containing ~~minimal~~ minimum # of atoms

primitive contains 1 atom, non-primitive contains 2

← reciprocal for primitive



← reciprocal for non-primitive

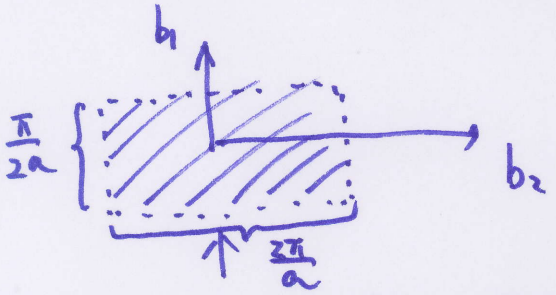
$|b_1| = \frac{2\pi}{4a} = \frac{\pi}{2a}$ $\quad |b_2| = \frac{2\pi}{a}$

$S = f[1 + e^{i x G}]$ $\quad x = (\frac{a}{2}, 2a)$ $\quad b_1 = (0, \frac{\pi}{2a})$ $\quad b_2 = (\frac{2\pi}{a}, 0)$

$G = n_1 b_1 + n_2 b_2 = (n_2 \frac{2\pi}{a}, n_1 \frac{\pi}{2a})$

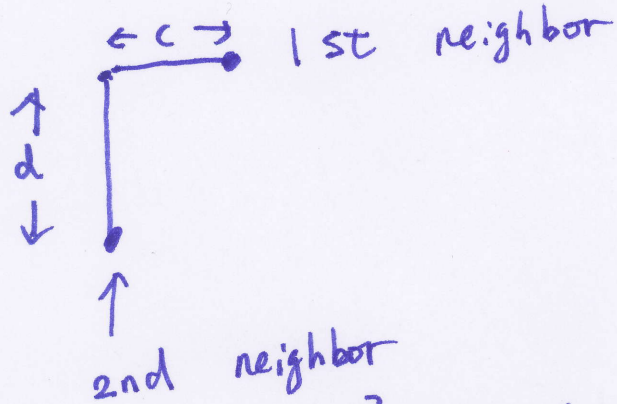
$S = f[1 + e^{i(n_2\pi + n_1\pi)}]$ extinction happens when $S = 0$,

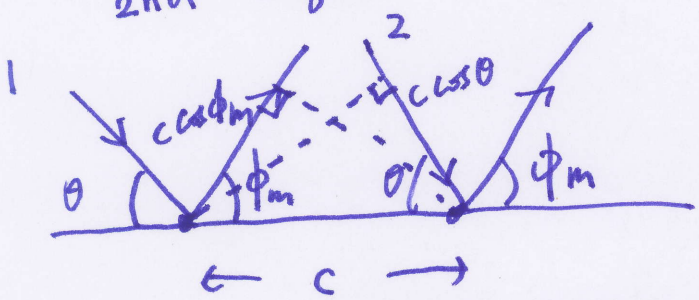
when $n_1 + n_2 = $ odd



1st Brillioun zone

2. because it's a rectangle lattice, if reinforce's 2 neighbors then all scattering will be reinforced.

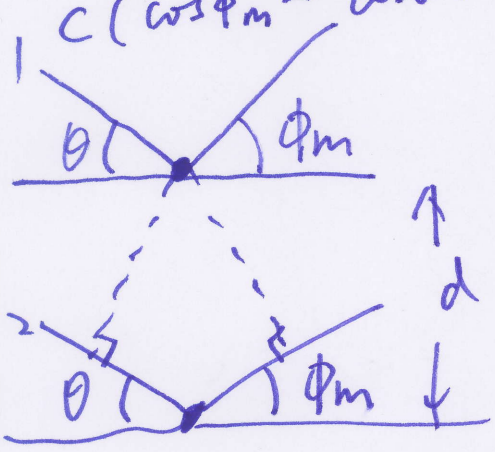




1st neighbor

ray 2 travels longer $c\cos\theta$ in incoming wave, but shorter $c\cos\phi_m$ in outgoing wave thus total difference is

$c(\cos\phi_m - \cos\theta) = m\lambda$ for reinforced interference.



ray 2 travels longer

$d\sin\theta + d\sin\phi_m$

thus

$d[\sin\theta + \sin\phi_m] = n\lambda$ for reinforced interference.

2nd neighbor

$\varphi = \frac{1}{2}(\phi_m + \theta)$ $\alpha = \frac{1}{2}(\phi_m - \theta)$

$d[\sin\theta + \sin\phi_m] = d(\sin(\varphi - \alpha) + \sin(\varphi + \alpha))$

$= d(2\sin\varphi\cos\alpha) = 2(d\cos\alpha)\sin\varphi = m\lambda$ ← Bragg form

$c[\cos\phi_m - \cos\theta] = c[\cos(\varphi+\alpha) - \cos(\varphi-\alpha)] = c(-2\sin\alpha)\sin\varphi = m\lambda$

$\rightarrow$ $2(c\sin\alpha)\sin\varphi = m\lambda$ ← Bragg form

3. $E = \frac{\hbar^2 |k|^2}{2m}$ corner $|k| = \left|\frac{\sqrt{2}\,\pi}{a}\right|$

mid of side $|k| = \left|\frac{\pi}{a}\right|$

$E_c = 2E_m$ due to k is $\sqrt{2}$ times

for sc it's similarly $\sqrt{3}\,|k|$ at corner

thus $E_c = 3E_m$ (or 1.5 depending on interpretation of problem)

this means it is conducting because not only the 1st band willed be filled, but also partially the 2nd. because electrons levels in 2nd band overlap in energy with 1st band

something like this