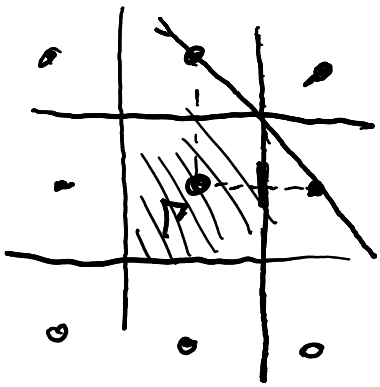
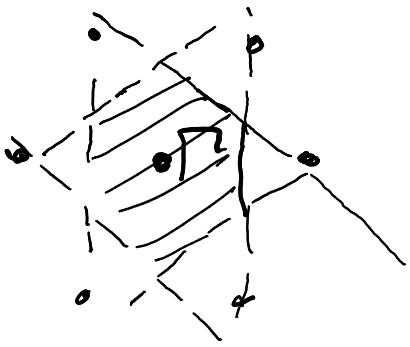
Brillouin zone

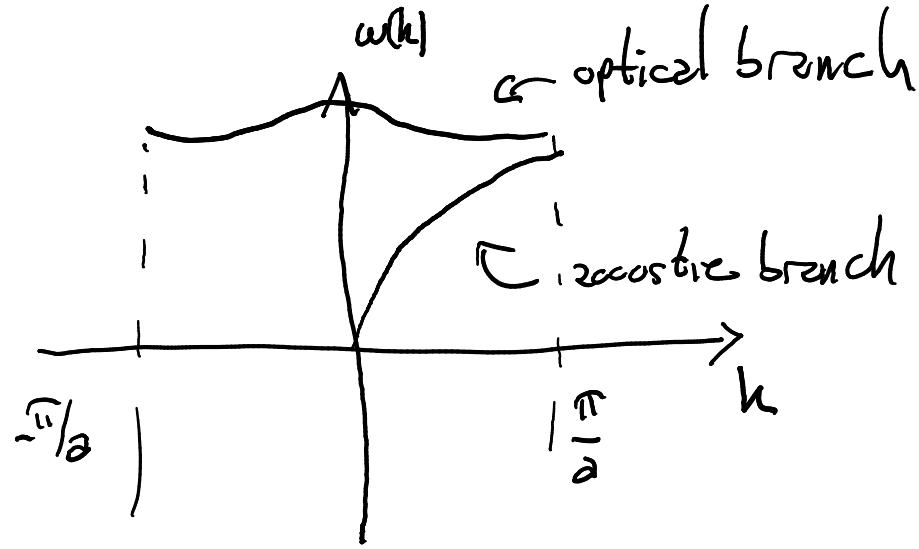
reciprocal space

1) pick origin Γ

2) BZ: set of all points closer to Γ than any other point

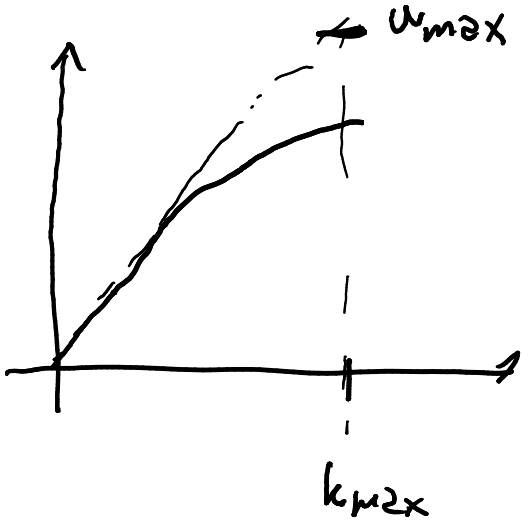






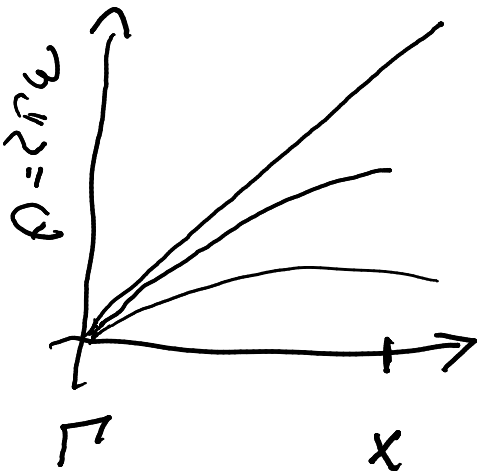
speed of sound: $v_s = \frac{d\omega}{dk}$

linear approximation



$v_s \sim \omega_{max} / k_{max}$

in real world



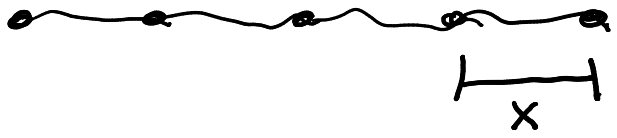
← different branches due to more than 2 atoms

ΓX = dist (100) plane

phonons

crystal => excitations

springs $|F| = -Cx$



collective excitation : phonon

mode of wave $u(x) = \sum_k u_k e^{ikx}$

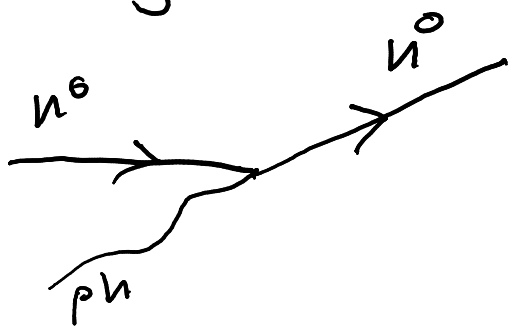
Debye Frequency $\omega = v_s k$

phonon energy ~> $E = \hbar\omega$ (by analogy to light)

remember $\omega = v_s k$

$k = \frac{2\pi}{\lambda}$

scattering



Energy conservation

$E_{ether} = E_{Left} + E_{ph}$