Today

I. Days that we'll be taking a break: A week from this Friday, Oct 23rd there will be no class or homework meetings, Wed Nov 25th also no class, or Fri Nov 27th.

II. Lab Paper: Select one experiment to write a full lab report o. Abstract, Introduction, Methods, Data & Analysis, Conclusion

III. Last Time

IV. Phase and Group Velocities

I. Yanpei Deng this week due to exam (will help in the lab. She's available M from 7-8pm in Brody lab).

This week: Antu Antu will be providing homework support. Hours are: Tu 8-9pm, Th10:30-11:30am, Th 8-9pm.

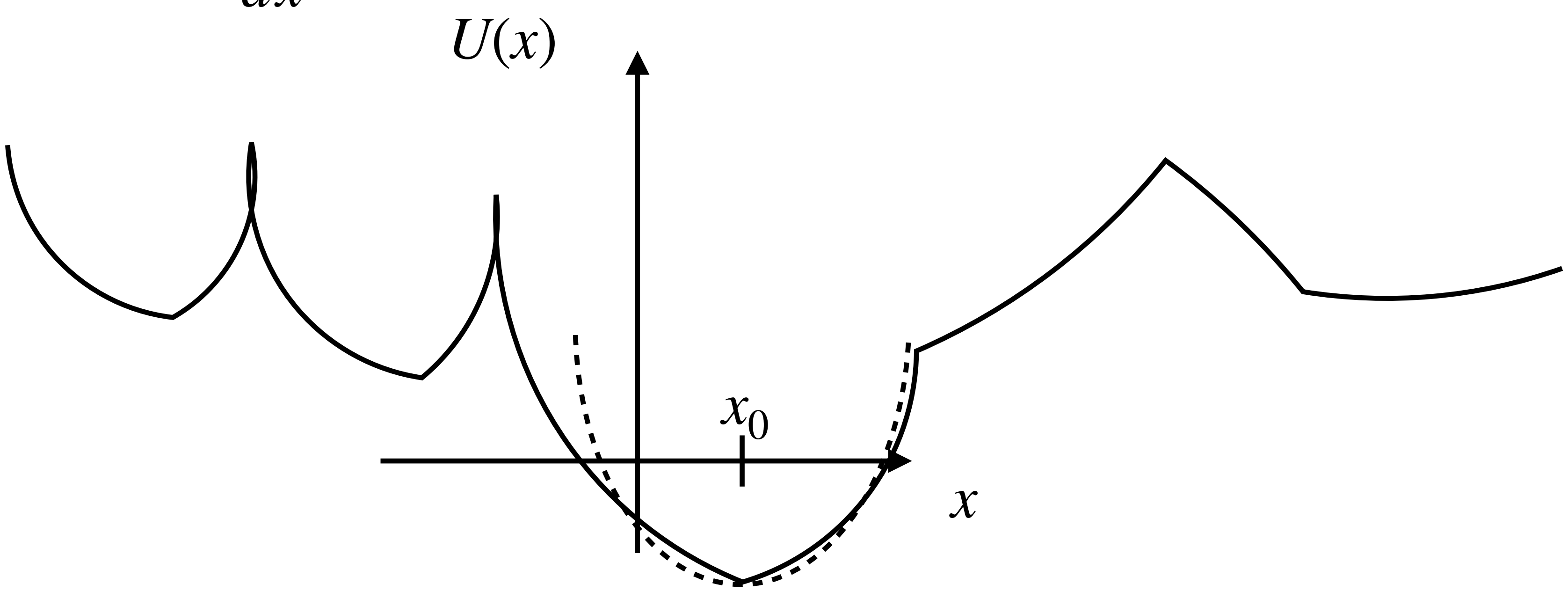
III. Last time we discussed a derivation of the wave equation. This was built on assuming that we had a chunk of material in equilibrium

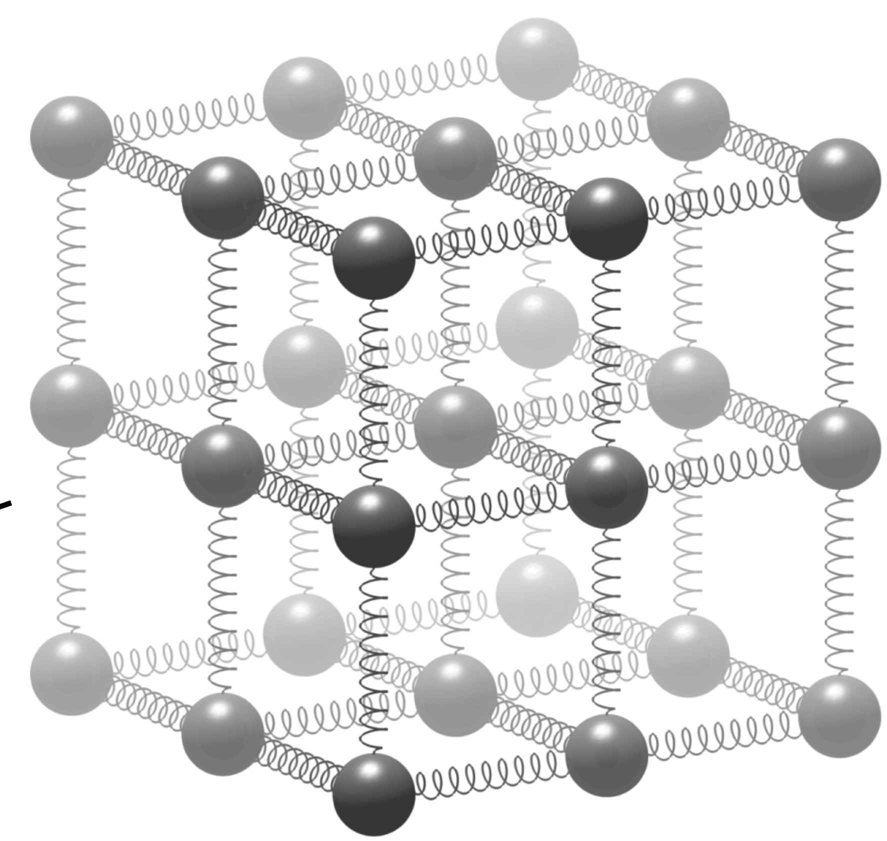
I. A chunk of material near a stable equilibrium acts like a harmonic oscillator. Through Newton's 2nd law and a detailed analysis of the net force on atomic chunks, we arrived at the wave equation

$$c^2 \frac{\partial^2 \psi(x,t)}{\partial x^2} = \frac{\partial^2 \psi(x,t)}{\partial t^2}, \qquad c = L\sqrt{\frac{K}{M}}.$$

This simple model predicts a wave speed that is the same no matter the frequency, wavelength, or wave number.

$$F(x) = -\frac{dU}{dx}$$



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In our previous treatment we pretended all the atoms of the solid were identical, all the springs were identical, that we could take the $d \to 0$ limit. None of these is strictly true!

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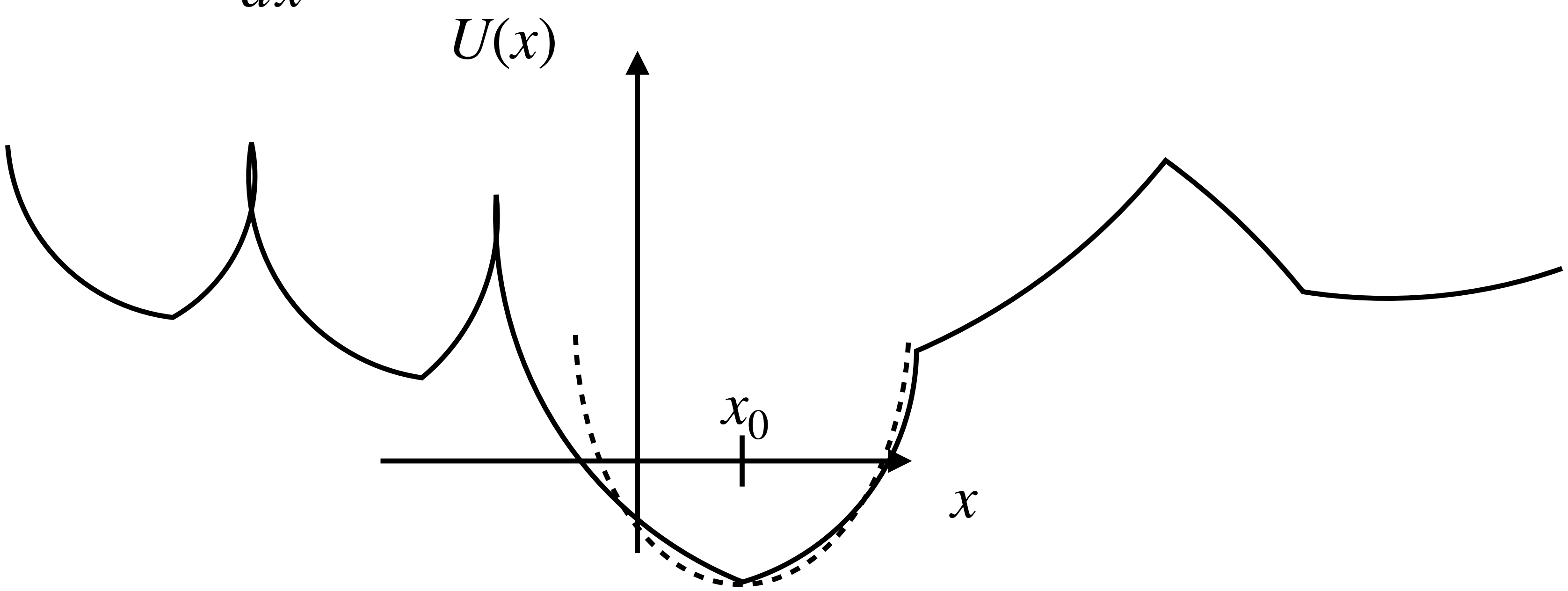
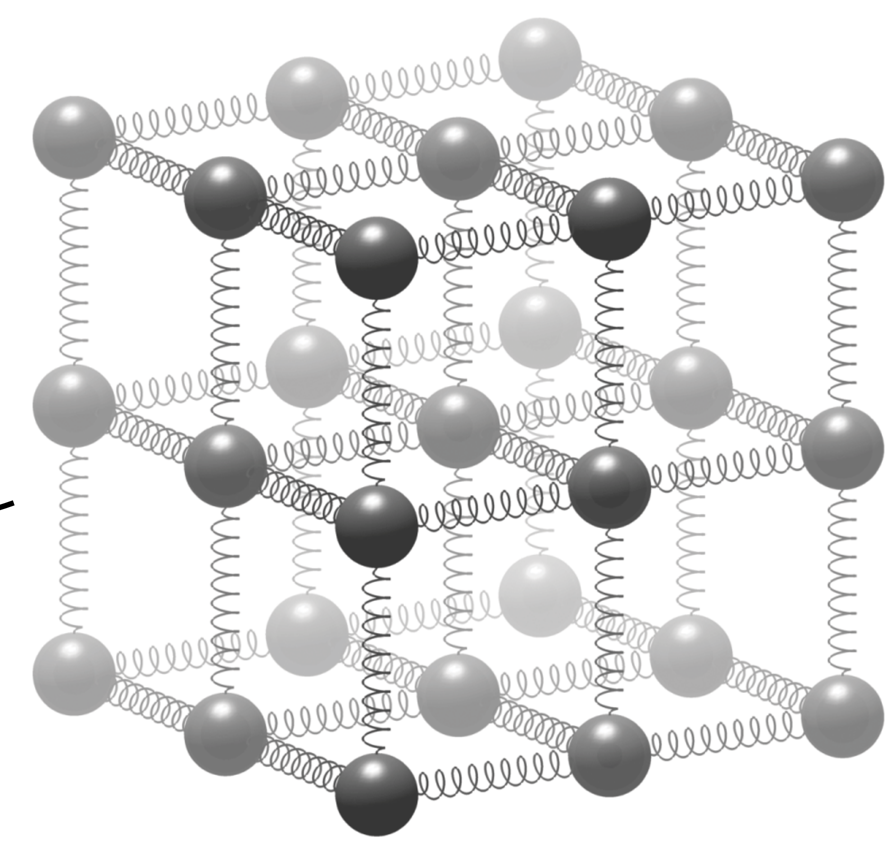
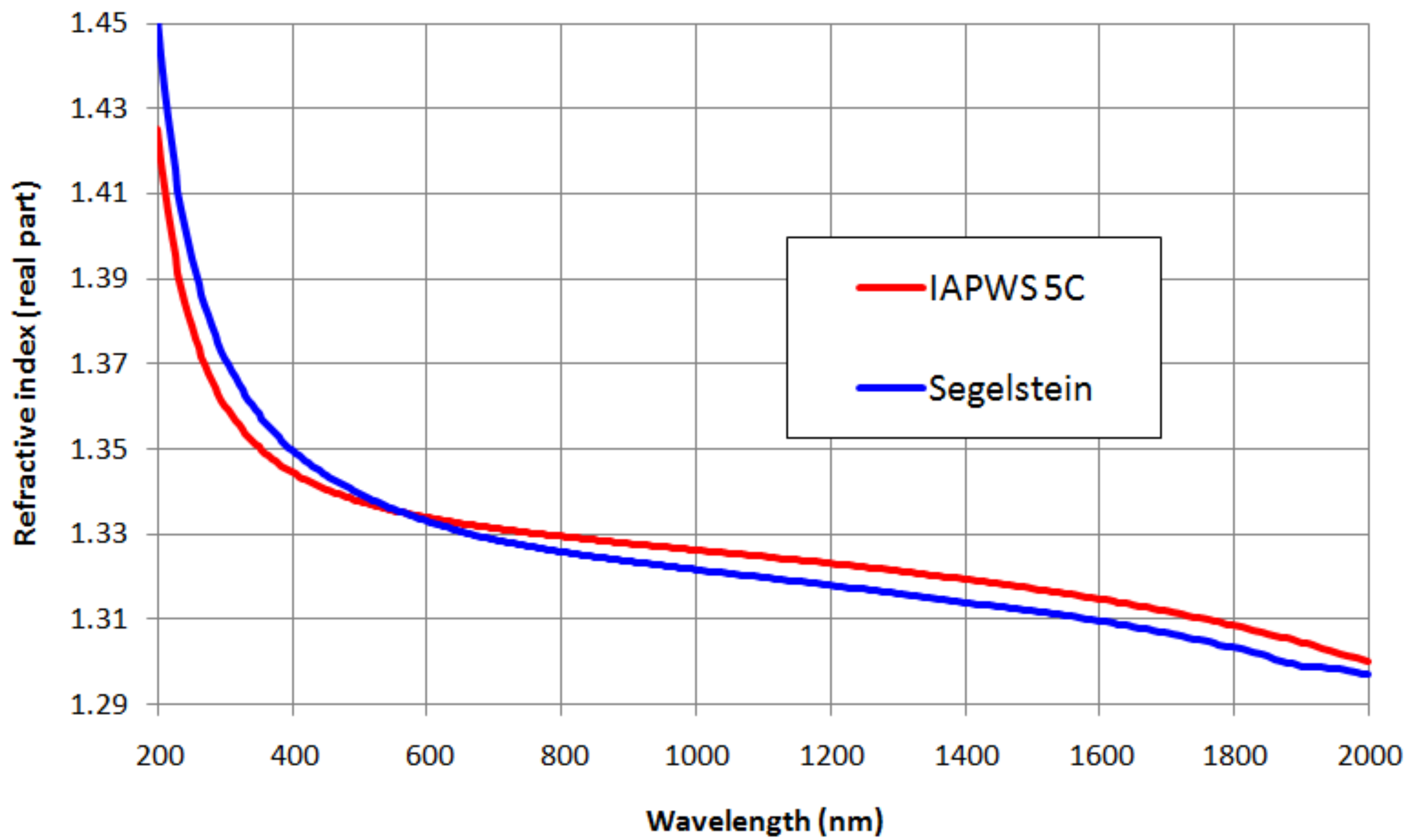


III. This plot gives the refractive index as a function of wavelength. Here focused on the visible and near visible.




This means that the wave speed in water varies, and in particular, shorter wavelengths have a slower wave speed than larger ones. We call this a "dispersion relation", and this example is n"normal dispersion". We study this with a dispersion relation: $\omega = \omega(k)$.

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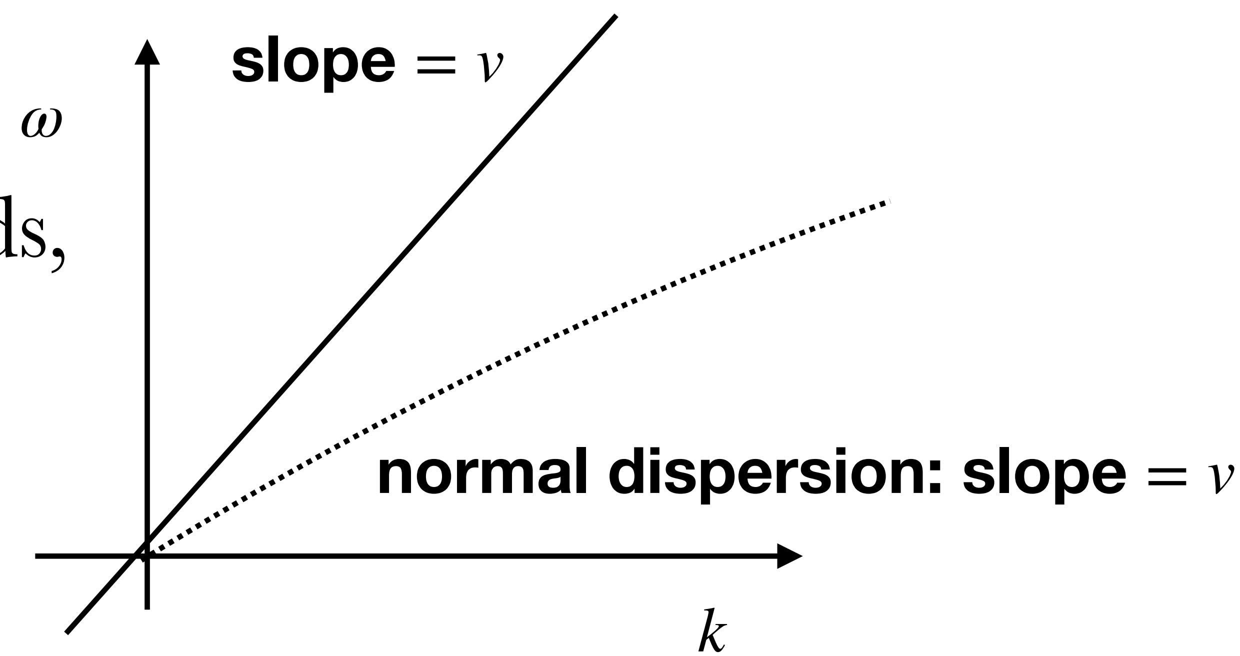


Recall that $v = \omega/k$, or in other words, $\omega(k) = vk$. Linear dispersion Holds for (a) light in vacuum (b) acoustic wave at low wave numbers $k$.

In general our wave equation will have a more complicated structure with $c(k)^2 \dfrac{\partial^2 \psi(x,t)}{\partial x^2} = \dfrac{\partial^2 \psi(x,t)}{\partial t^2}$ and we still have $c(k) = \dfrac{\omega(k)}{k}$ the "phase velocity."

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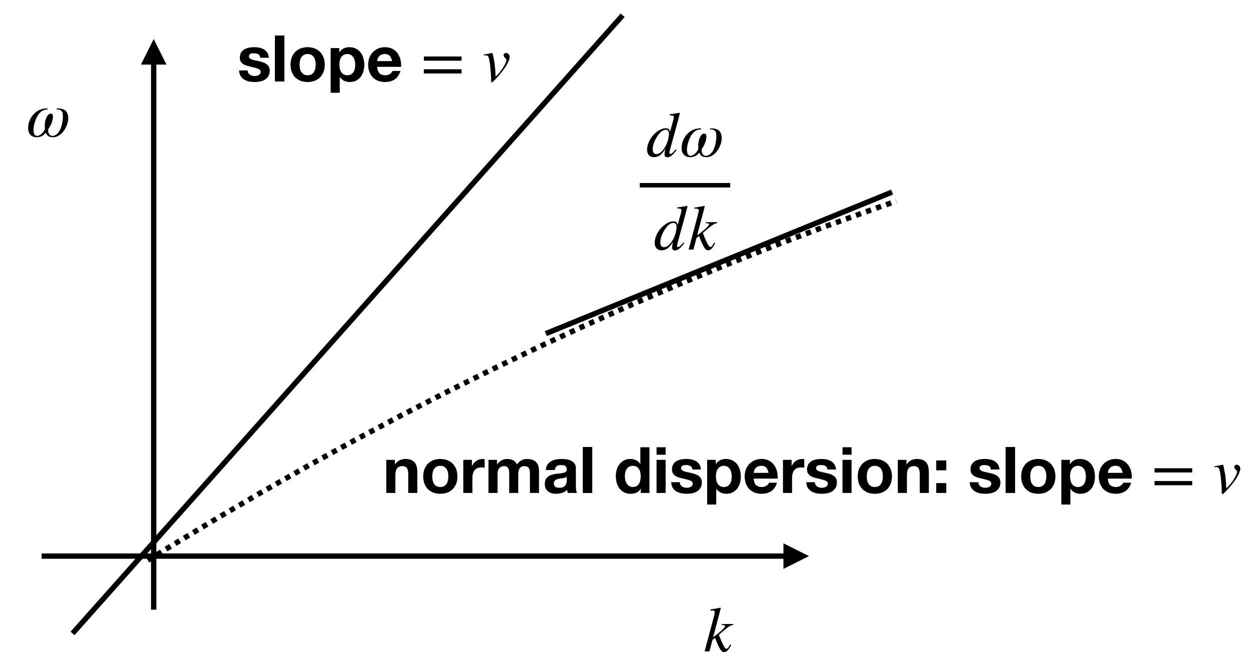


We can also consider

$$v_{\text{group}} = \lim_{\Delta k \to 0} \frac{\Delta \omega}{\Delta k} = \frac{d\omega}{dk}$$