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. What's Next?
V. Pressure

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. We explored group and phase velocity:

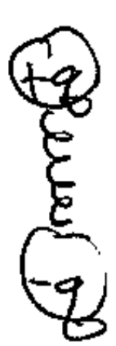
Phase velocity: $v = \dfrac{\omega(k)}{k} = f\lambda$ [We call $\omega(k)$ a dispersion relation.]

Group velocity: $v_g = \lim\limits_{\Delta k \to 0} \dfrac{\Delta\omega}{\Delta k} = \dfrac{d\omega}{dk}$.

Went through lots of examples of different behaviors.

IV. We have noticed that materials absorb E&M waves (attenuation). But, they also create waves! How? Accelerating charges create E&M waves. How do the charges get set into motion? Again charges in a material must be in stable equilibrium

—> use spring model



Electromagnetic Resonator

IV. How do you get it to vibrate? Heat! This heat was first thought of as a fluid, and was later recognized as microscopic motions of atoms and molecules. You have seen heat doing its job, increasing the temperature of an object and eventually if it is hot enough it will radiate in the visible too.

In fact, all object at $T > 0K$ produced E&M waves, it's just that they're largely invisible. Different material emit different λ preferentially. This is due to particular details of how the charges are arranged and how they vibrate in the materials. So, we see that to better understand how materials emit radiation we should study their bulk mechanical properties (e.g. pressure) and understand heat and temperature. This is <u>Thermodynamics</u>.

V. (1) <u>Pressure:</u> Force per unit area: $P = \frac{F}{A}$. Units: $[P] = \frac{\mathrm{N}}{m^2} \equiv 1\mathrm{Pa}$.

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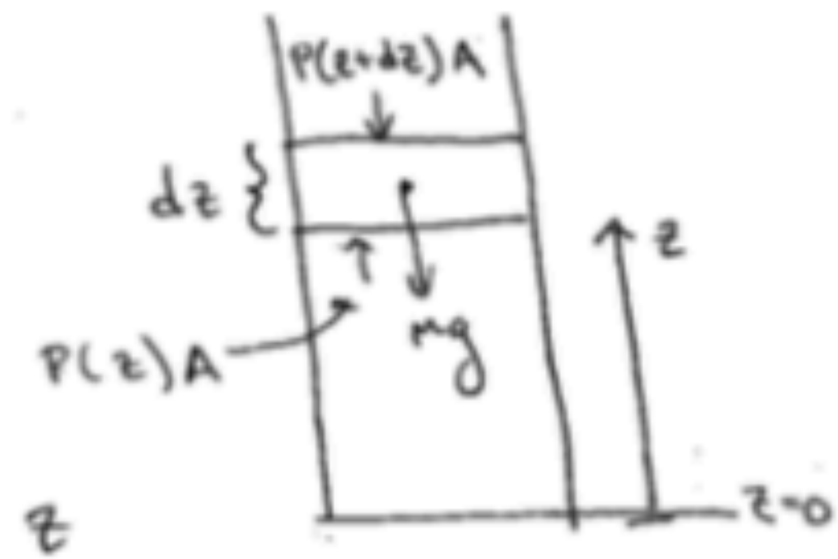
Pressure does not point (or if you prefer, it points in all directions).

(2) How does pressure vary with depth? It increases! Let's try to characterize this quantitatively:



Consider a slab of the air with thickness dz and a cross-sectional area A. The pressure differential between the top of the slab and its bottom is what makes it so that the slab doesn't move. This differential is what is balancing the weight of the slab. The force down on the top surface is $P(z + dz) \cdot A$ and that on the bottom surface is $P(z)A$, then

$$-P(z + dz)A + P(z)A = -mg = -\rho A dz g.$$

$$\frac{P(z + dz) - P(z)}{dz} = \rho g \quad \Longrightarrow \quad \frac{dP}{dz} = \rho g.$$

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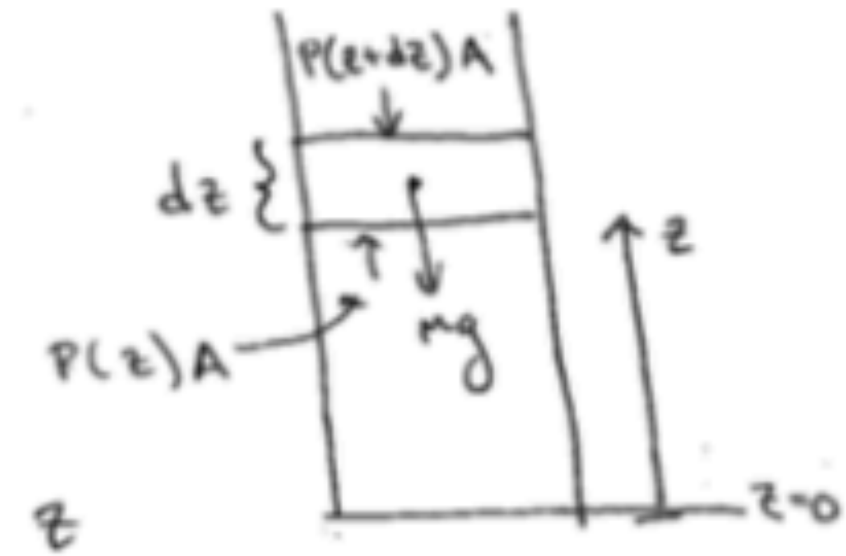

$-P(z + dz)A + P(z)A = mg = \rho A dz g.$

$\dfrac{P(z + dz) - P(z)}{dz} = -\rho g \implies \dfrac{dP}{dz} = -\rho g$. We can separate variables $dP = -\rho g dz$, which gives $\int dP = -\int \rho g dz$ and finally $P = P(0) - \rho g z$. Throughout ρ is the "density" $\rho \equiv \dfrac{m}{V}$.