1.) $\vec{p} = \alpha \vec{E}$ for an atom $\left(\frac{\text{dipole mom}}{\text{atom}} \right)$

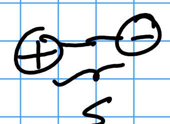
$\vec{P} = \epsilon_0 \chi_e \vec{E}$ for a collection of atoms $\left(\frac{\text{dipole mom}}{m^3} \right)$

$$\rho \vec{p} = \rho \alpha \vec{E} = \epsilon_0 \chi_e \vec{E} \Rightarrow \chi_e = \frac{\rho \alpha}{\epsilon_0}$$

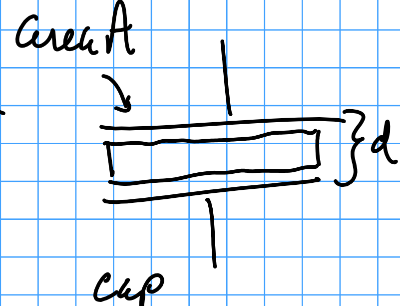
If we know χ_e from a measurement of capacitance & ρ & ϵ_0 so we can solve for polarizability α.

α can be calculated using Quantum Mechanics

from $\langle \vec{p} \rangle = \int \psi^* q s \psi \, d\tau$



How do we find χ_e? Measure Capacitance



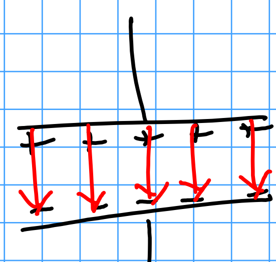
$C = \frac{\epsilon}{\epsilon_0} C_{vac} = (1+\chi_e) C_{vac}$

$C = \frac{\epsilon_0 A}{d}(1+\chi_e)$ see lecture notes

measure

Solve for χ_e

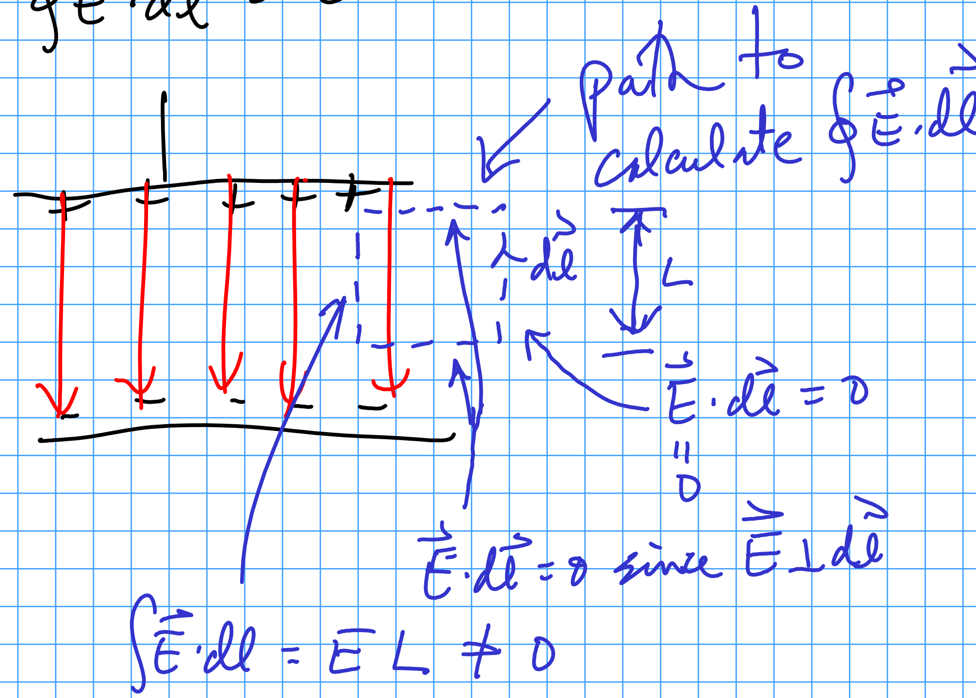
2.) Can this exist?



OR can E abruptly go the zero?

Use stokes theorem on $\vec{\nabla} \times \vec{E} = 0$

$$\int \underbrace{\vec{\nabla}\times\vec{E}}_{=0}\cdot d\vec{a} = \oint \vec{E}\cdot d\vec{l} = 0$$



Conclusion: If there is no fringing field then

$\oint \vec{E}\cdot d\vec{l} \neq 0$ but it must be $\emptyset$ so