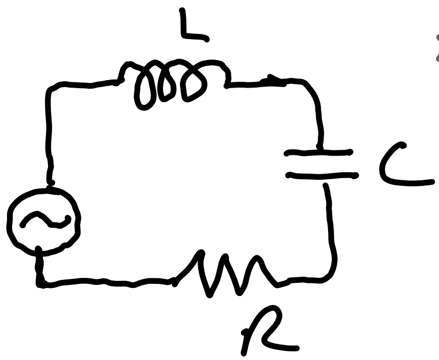
Physics 142 - November 9, 2010

Exam 2

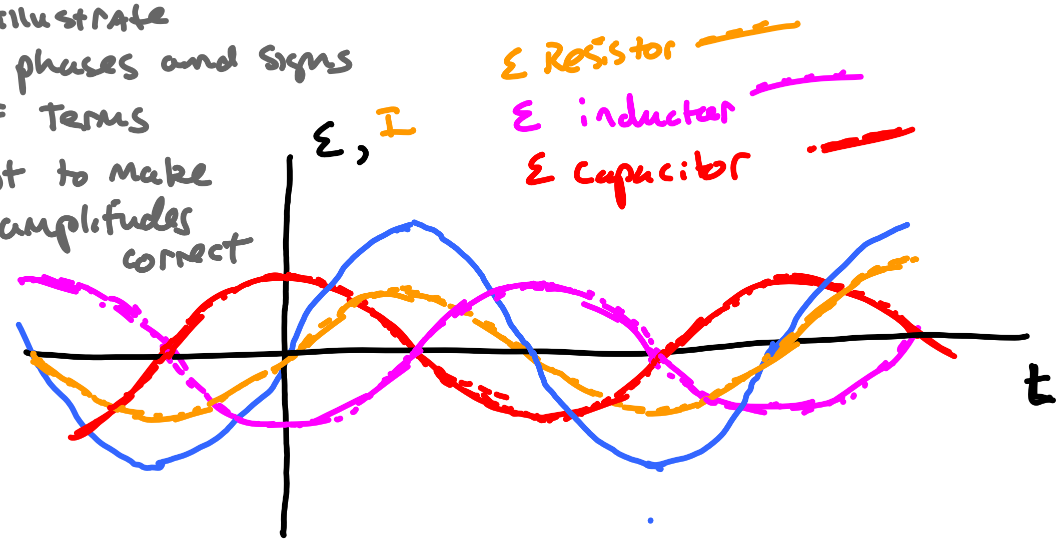
- 0800 Tues. Nov. 16 LOC TBA
- Q+A Session Mon 4:30-6:00 Loc TBA
- Material up to AC circuits (thru LC oscillations)
  - Thru workshop 9
  - Thru prob 6 on P.S. 9
  - Thru p.13 of Nov. 2 lecture

Last Time -



Graph to illustrate relative phases and signs of EMF terms

No attempt to make relative amplitudes correct



$$\mathcal{E} = \underbrace{\Delta V_R}_{R I_{max} \sin(\omega t + \phi)} + \underbrace{\Delta V_C}_{-X_C I_{max} \cos(\omega t + \phi)} + \underbrace{\Delta V_L}_{X_L I_{max} \cos(\omega t + \phi)}$$

$$\mathcal{E} = \mathcal{E}_{max} \sin \omega t$$

general Expression $I = I_{max} \sin(\omega t + \phi)$

unknown

$$\mathcal{E} = \Delta V_R + \Delta V_c + \Delta V_L$$

$$\mathcal{E}_{max} \sin \omega t = R I_{max} \sin(\omega t + \phi) - \chi_c I_{max} \cos(\omega t + \phi) + \chi_L I_{max} \cos(\omega t + \phi)$$

χ_c: Acts as "Resistance" of capacitor

χ_L: Acts as "Resistance" of Inductor

$$\tan \phi = \frac{\chi_L - \chi_c}{R}$$

$$I_{max} = \frac{\mathcal{E}_{max}}{\sqrt{R^2 + (\chi_L + \chi_c)^2}}$$

$$Z \equiv \sqrt{R^2 + (\chi_L + \chi_c)^2}$$

Impedance

Acts as TOTAL Resistance of LRC circuit

$$\tan\varphi = \frac{X_L - X_C}{R}$$

$$I_{max} = \frac{\mathcal{E}_{max}}{\sqrt{R^2 + (X_L + X_C)^2}}$$

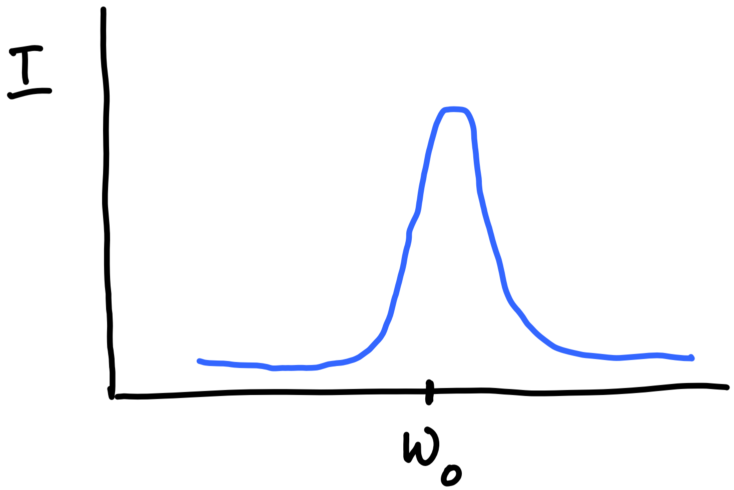
$\equiv$ Impedance $\equiv Z$

Plays Role of Resistance in LRC circuit

(~) → Frequency ω

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

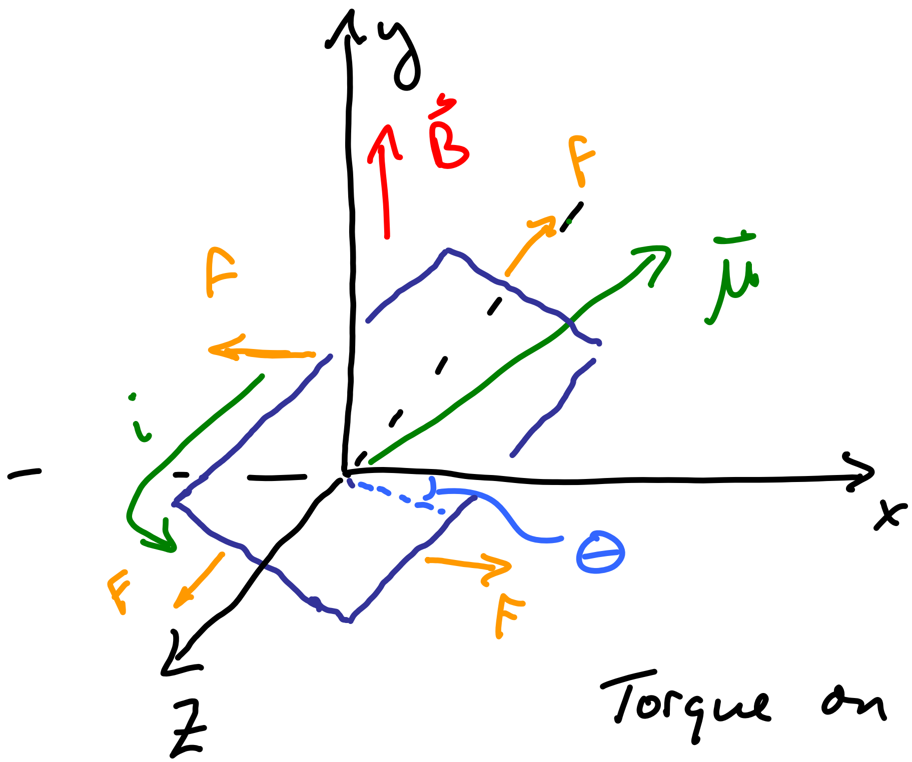
$$\omega \rightarrow \omega_0 = \frac{1}{\sqrt{LC}}$$

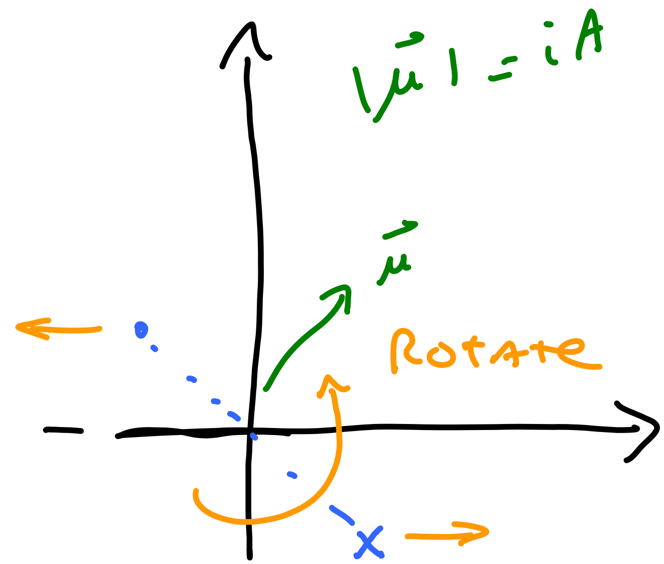


$$\frac{1}{\sqrt{LC}}$$

Resonance

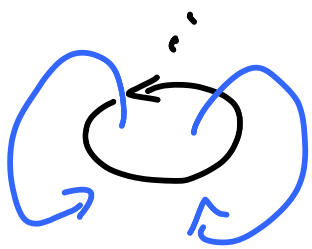
Magnetic Fields in Matter





Torque on current loop

$$\vec{\tau} = \vec{\mu} \times \vec{B}$$



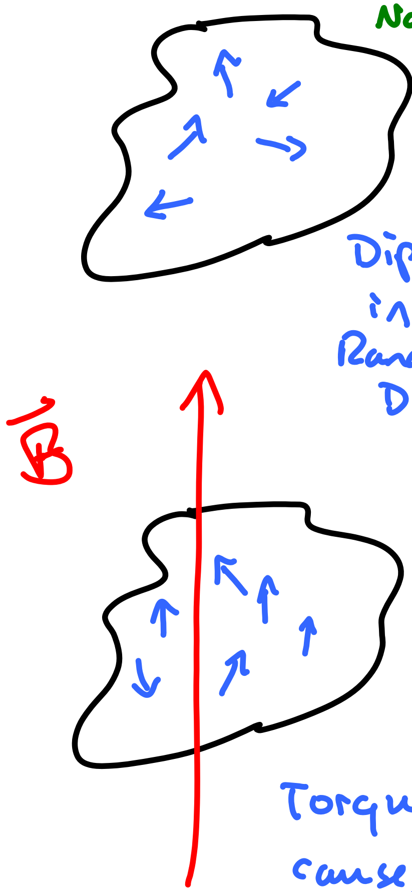
Dipole form

$$|\vec{\mu}| = iA$$

Magnetism in Materials

Paramagnetic

Natural Dipoles

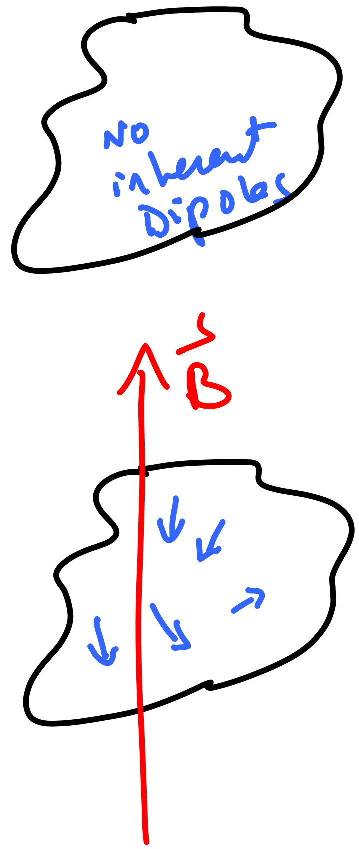


Dipoles in Random Directions

Torque causes some Alignment

→ $\vec{B}$ is increased

Diamagnetic

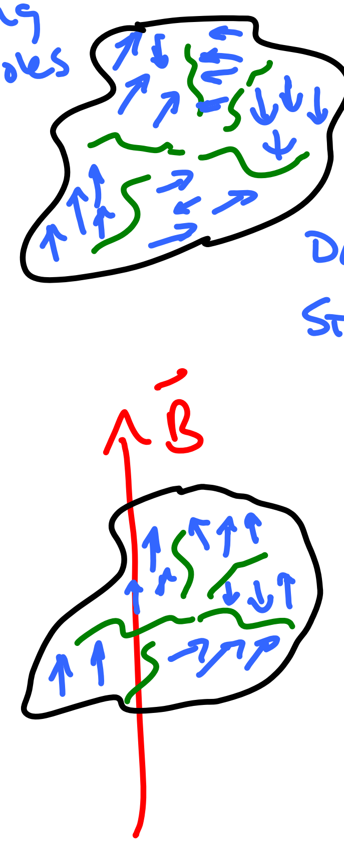


induced Dipoles oppose $\vec{B}$

→ $\vec{B}$ weakened

Ferromagnetic

Strong Dipoles



Domain Structure

External field Aligns domains

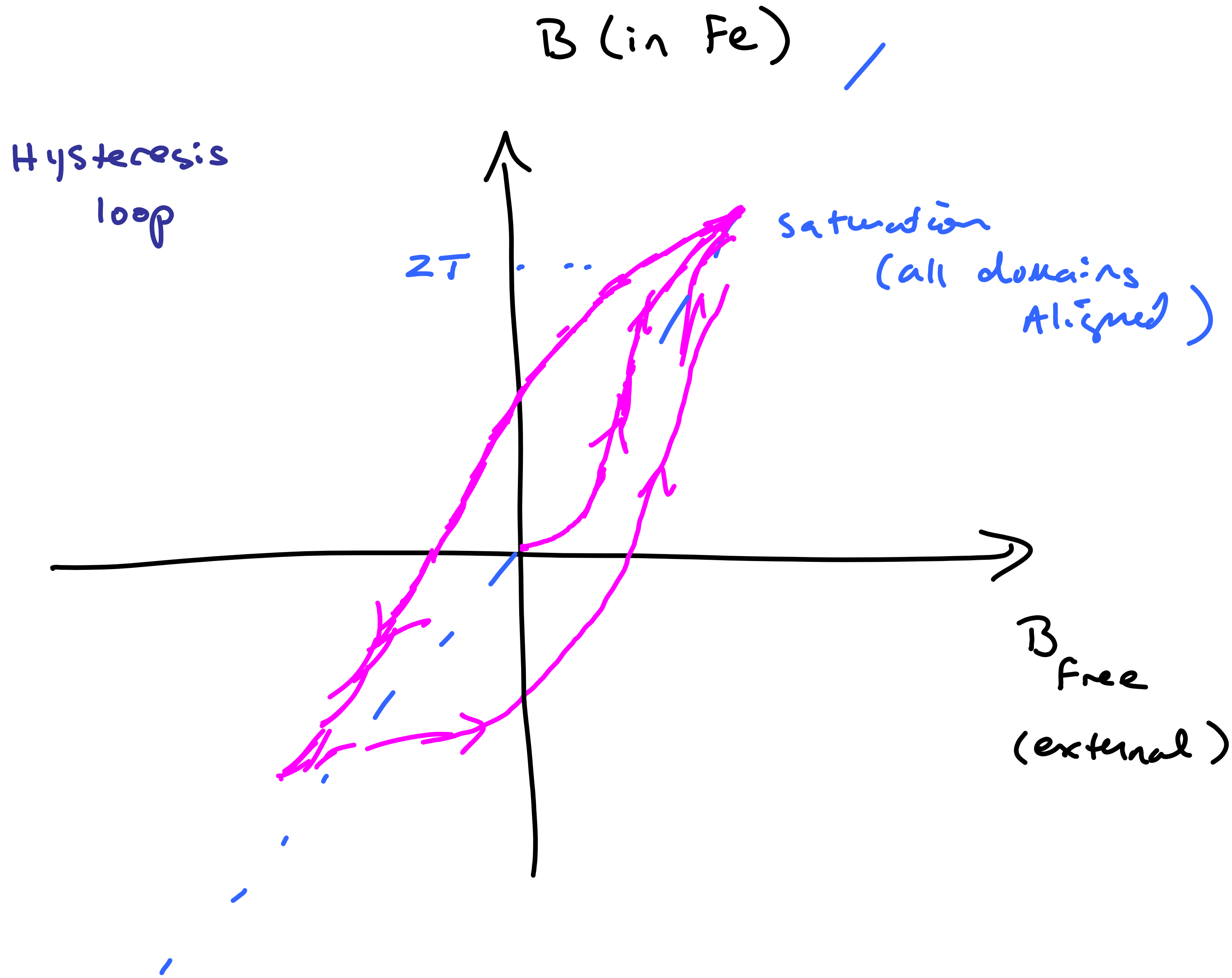
→ $\vec{B}$ increased

$$B_{\text{in Material}} = \mu_0 (1 + \chi_M) B_{\text{free or ExT}}$$

χ_M: Magnetic Susceptibility

$1 + \chi_M$: relative Permeability κ_M

$\mu_0 \kappa_M$: Permeability $\to \mu$


Hysteresis loop
B (in Fe)
2T
saturation (all domains Aligned)
B free (external)

Gauss $$\int_S \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

No Magnetic Monopoles $$\int_S \vec{B}\cdot d\vec{A} = 0$$

Ampere $$\int_C \vec{B}\cdot d\vec{l} = \mu_0 \overbrace{\int_S \vec{j}\cdot d\vec{A}}^{I_{enclosed}} + \mu_0\epsilon_0 \frac{d}{dt}\int \vec{E}\cdot d\vec{A}$$

Faraday $$\int_C \vec{E}\cdot d\vec{l} = -\frac{d}{dt}\int \vec{B}\cdot d\vec{A}$$