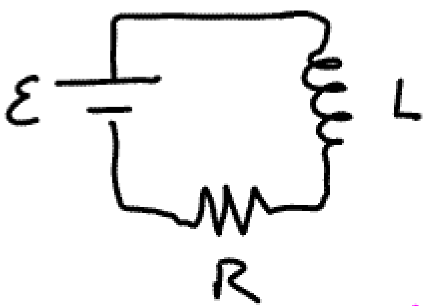
Physics 142 – November 13, 2007

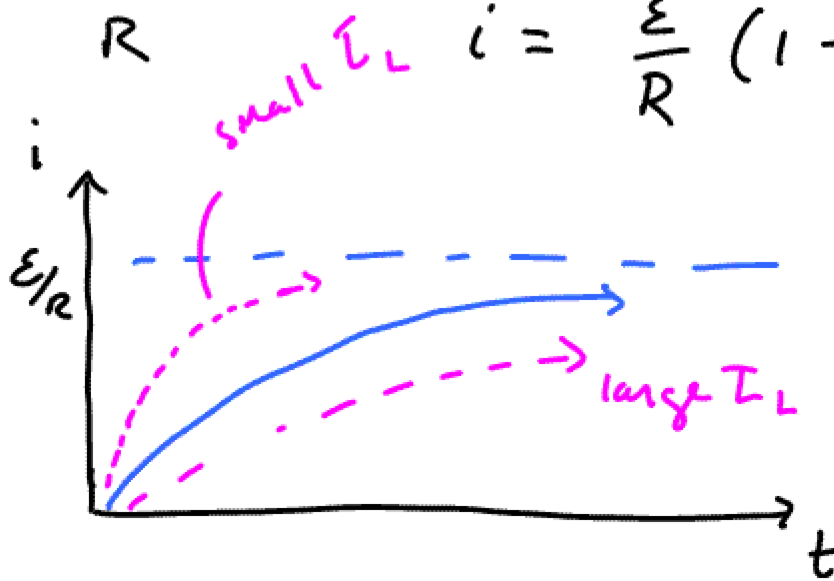
- Hope to return exam on Thursday

Last Time –

LR circuit

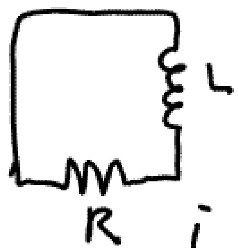


$$i = \frac{\mathcal{E}}{R}\left(1 - e^{-tR/L}\right) = \frac{\mathcal{E}}{R}\left(1 - e^{-t/\tau_L}\right)$$

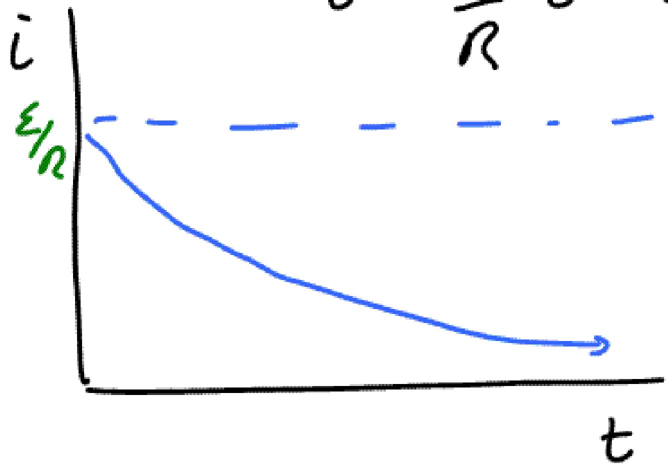


Induction time constant

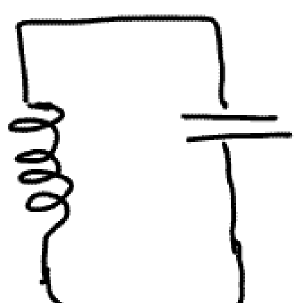
$$\frac{L}{R} = \tau_L$$



$$i = \frac{\mathcal{E}}{R} e^{-t/\tau_L} = i_0 e^{-t/\tau_L}$$



LC circuit $U = U_B + U_E = \frac{1}{2}Li^2 + \frac{q^2}{2C}$



Look at $\frac{dU}{dt}$

$$0 = L\frac{d^2q}{dt^2} + \frac{q}{C}$$

diff eqn

$$q(t) = Q\cos(\omega t + \varphi)$$

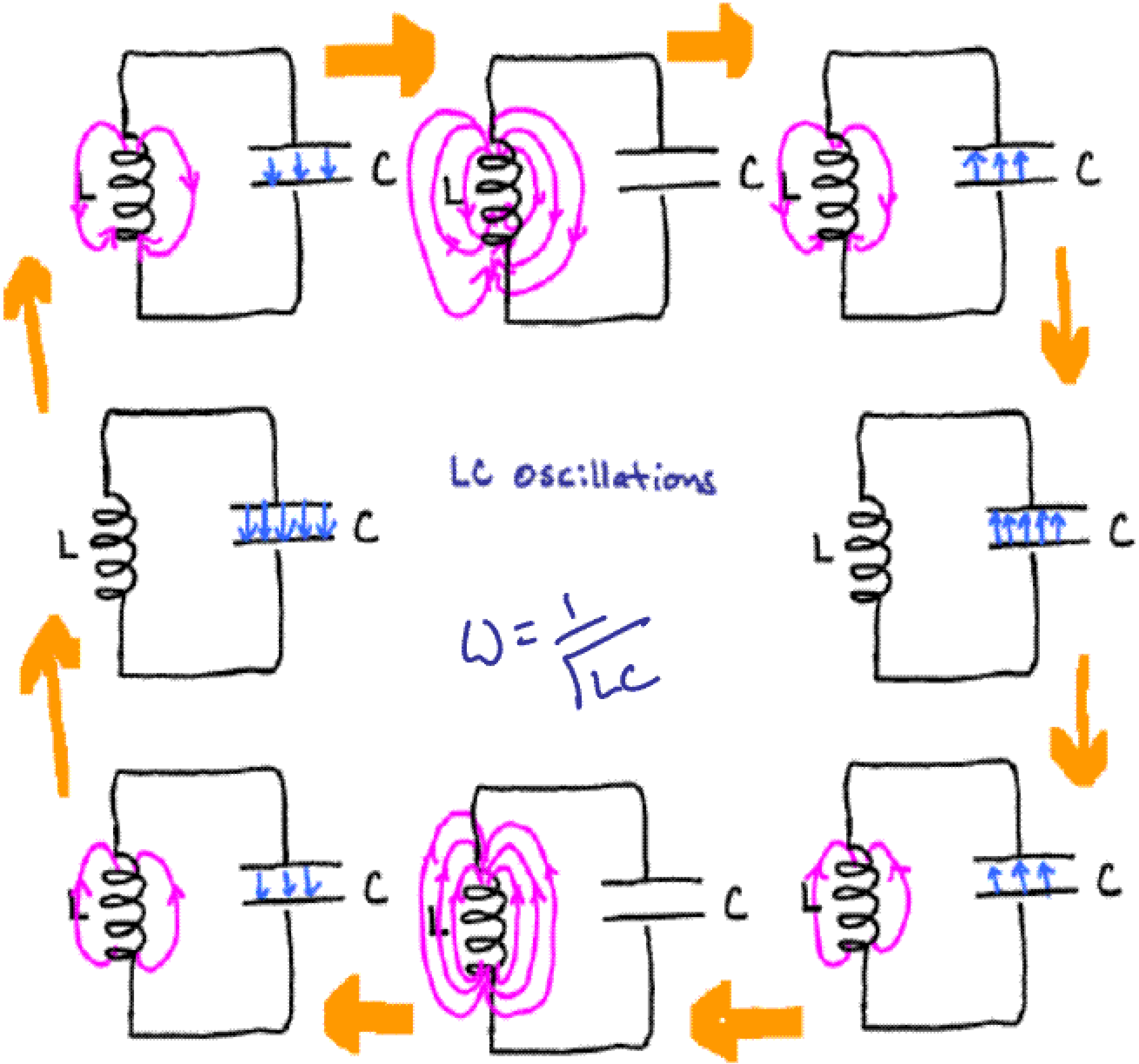
$$\omega = \frac{1}{\sqrt{LC}}$$

HARMONIC

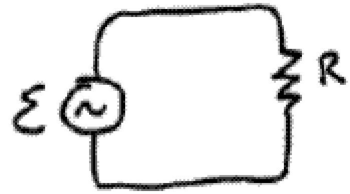
Energy flow

$$U_E = \frac{q^2}{2C} = \frac{Q^2}{2C}\cos^2(\omega t + \varphi)$$

$$U_B = \frac{1}{2}Li^2 = \frac{L}{2}Q^2\omega^2\sin^2(\omega t + \varphi)$$


LC oscillations
$\omega = \frac{1}{\sqrt{LC}}$
L
C

AC Circuits



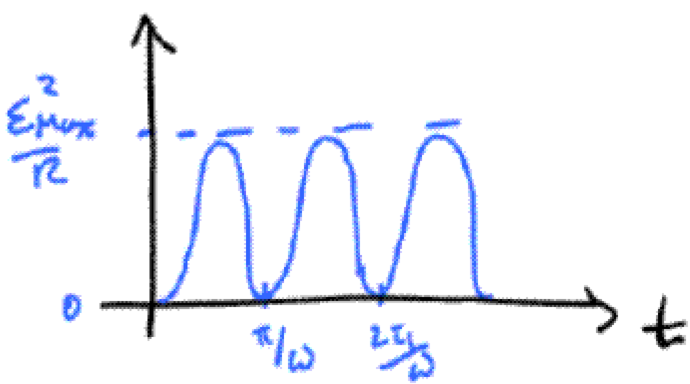
$\mathcal{E} = \mathcal{E}_{max} \sin \omega t$

Kirchoff $\quad \mathcal{E} - IR = 0$

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

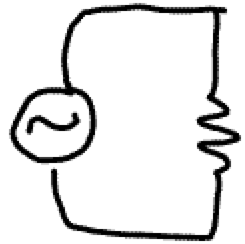
Instantaneous Power Dissipation

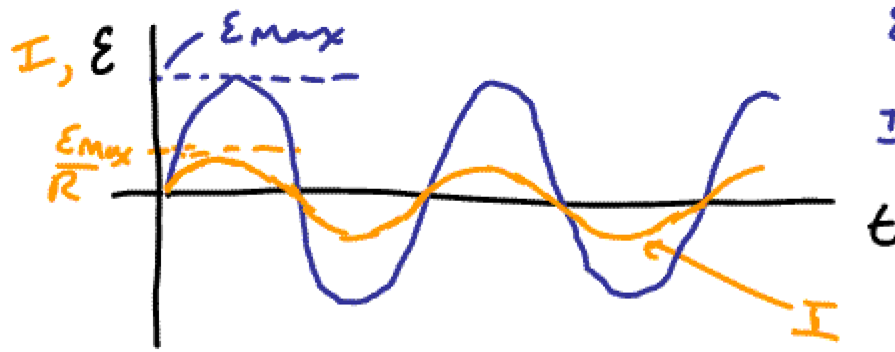
$$P = IV = I\mathcal{E} = \frac{\mathcal{E}_{max}^2}{R} \sin^2 \omega t$$



$\overline{\sin^2 \theta} \to \frac{1}{2}$

Ave power $\quad \bar{P} = \frac{\mathcal{E}_{max}^2}{2R}$



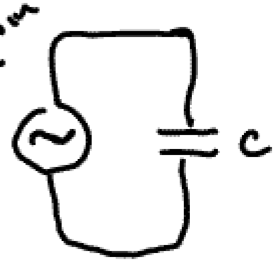


In phase

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

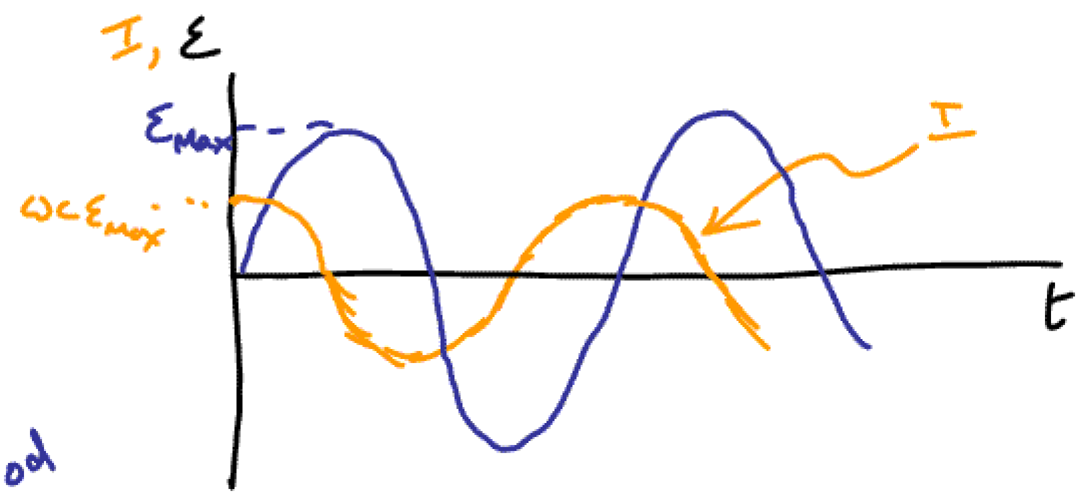
$I = \dfrac{\mathcal{E}_{max}}{R} \sin \omega t$

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



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

$I = \dfrac{dQ}{dt} = \omega C \mathcal{E}_{max} \cos \omega t$



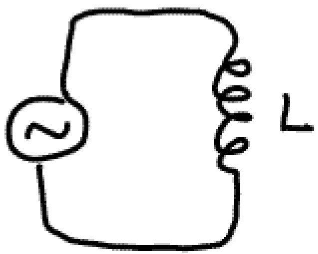
I "leads" EMF by 1/4 period cycle

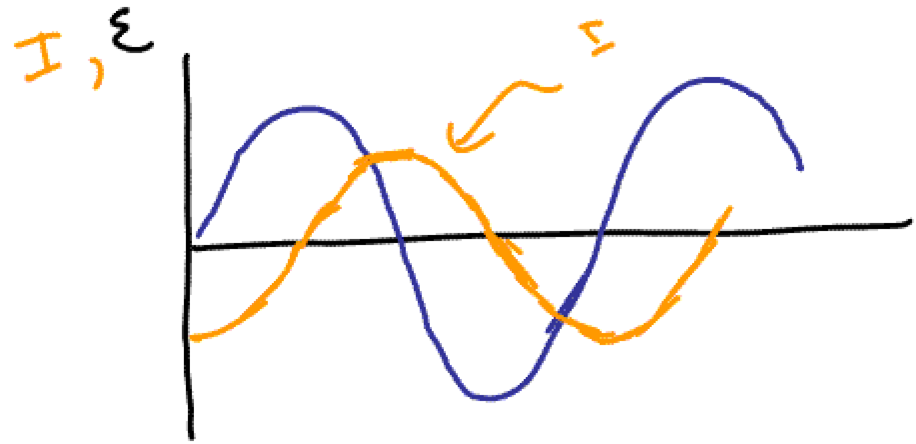
$V \sim IR$

$\boxed{\frac{1}{\omega C}} I = \mathcal{E}_{max} \cos\omega t$

↳ plays role of Resistance in capacitive AC circuit

$X_C \equiv$ Capacative Reactance





$\mathcal{E} - L\frac{dI}{dt} = 0$

$\frac{dI}{dt} = \frac{\mathcal{E}_{max}\sin\omega t}{L}$

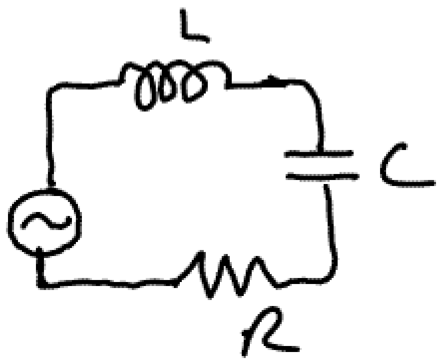
$I = -\frac{\mathcal{E}_{max}\cos\omega t}{\omega L}$

I "lags" EMF by ¼ cycle

$\omega L \equiv X_L \equiv$ Inductive Reactance

$I X_L = -\mathcal{E}_{max} \cos \omega t$

Think
$\approx$ $V = IR$



LRC circuit

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

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

phase ?

?

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

ΔV_L: $X_L I_{max} \cos(\omega t + \phi)$

ΔV_R: $R I_{max} \sin(\omega t + \phi)$

ΔV_C: $-X_C I_{max} \cos(\omega t + \phi)$

¼ cycle behind $\mathcal{E}$, I

Math, Trig ID's

look at text

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

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

plays Role of "R" in LRC circuit

$\equiv$ Impedance $\equiv Z$

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

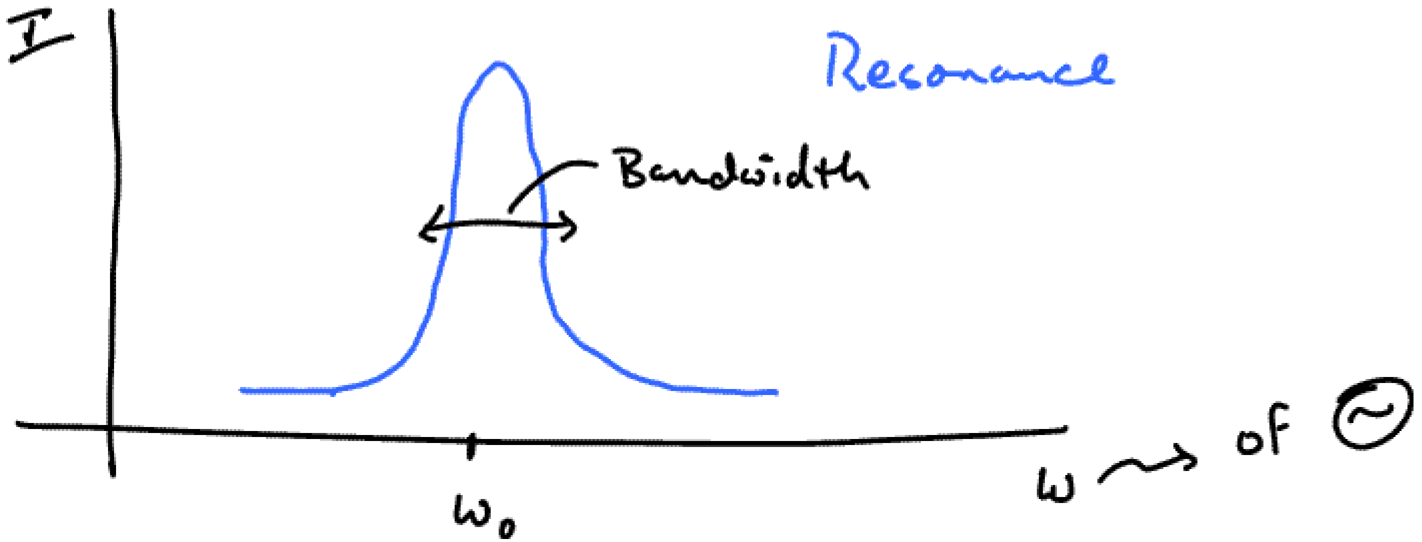
have $\odot$ at freq ω

look at $\omega \to \omega_0 = \frac{1}{\sqrt{LC}}$

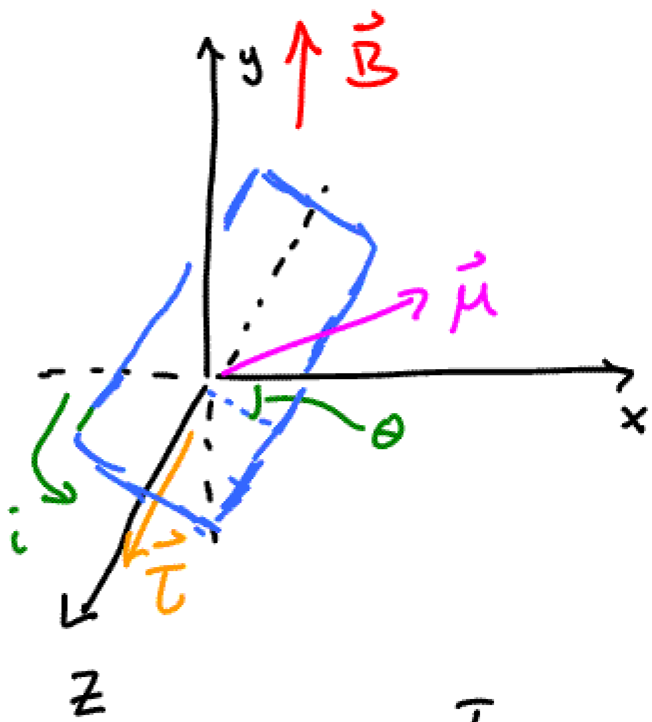
$$Z \to \sqrt{R^2 + \left(\frac{L}{\sqrt{LC}} - \frac{\sqrt{LC}}{C}\right)^2}$$

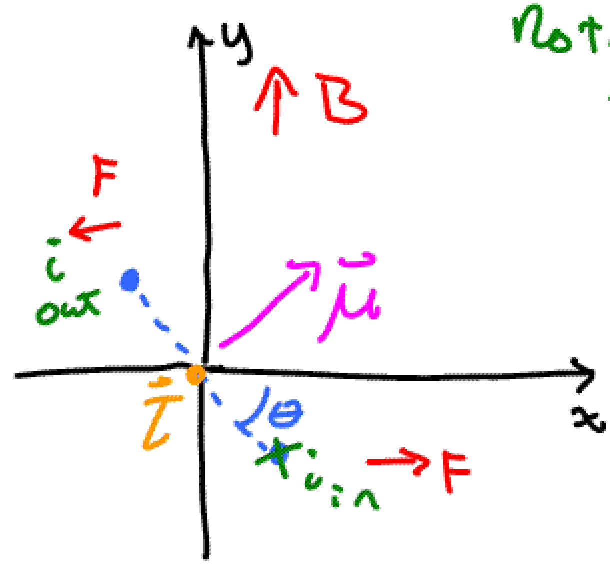
$\to 0$

$\to$ maximizes I


I
Resonance
Bandwidth
ω_0
ω ⇝ of

Magnetic fields in matter

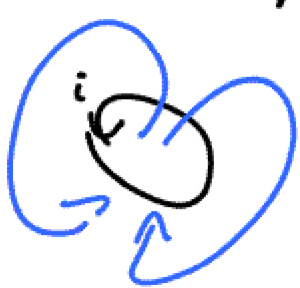




Axis of Rotation is z-Axis

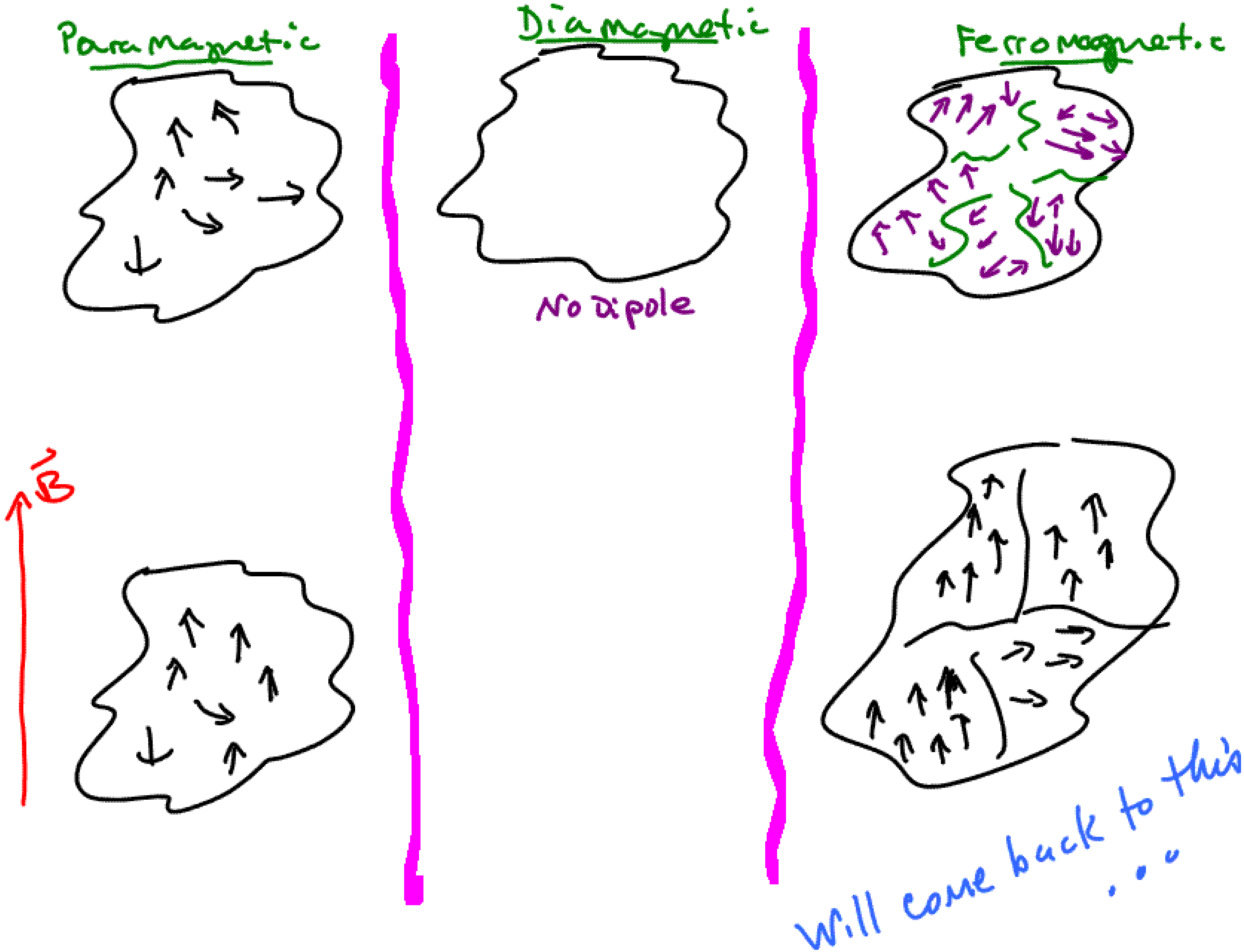
Torque on current loop $= \vec{\mu} \times \vec{B} = \vec{\tau}$

Dipole



Dipole magnetic field

Define Magnetic Moment of current loop $\equiv I A = |\vec{\mu}|$ (A: cross sect. Area of loop)



Paramagnetic
Diamagnetic
Ferromagnetic
No Dipole
$\vec{B}$
Will come back to this ...