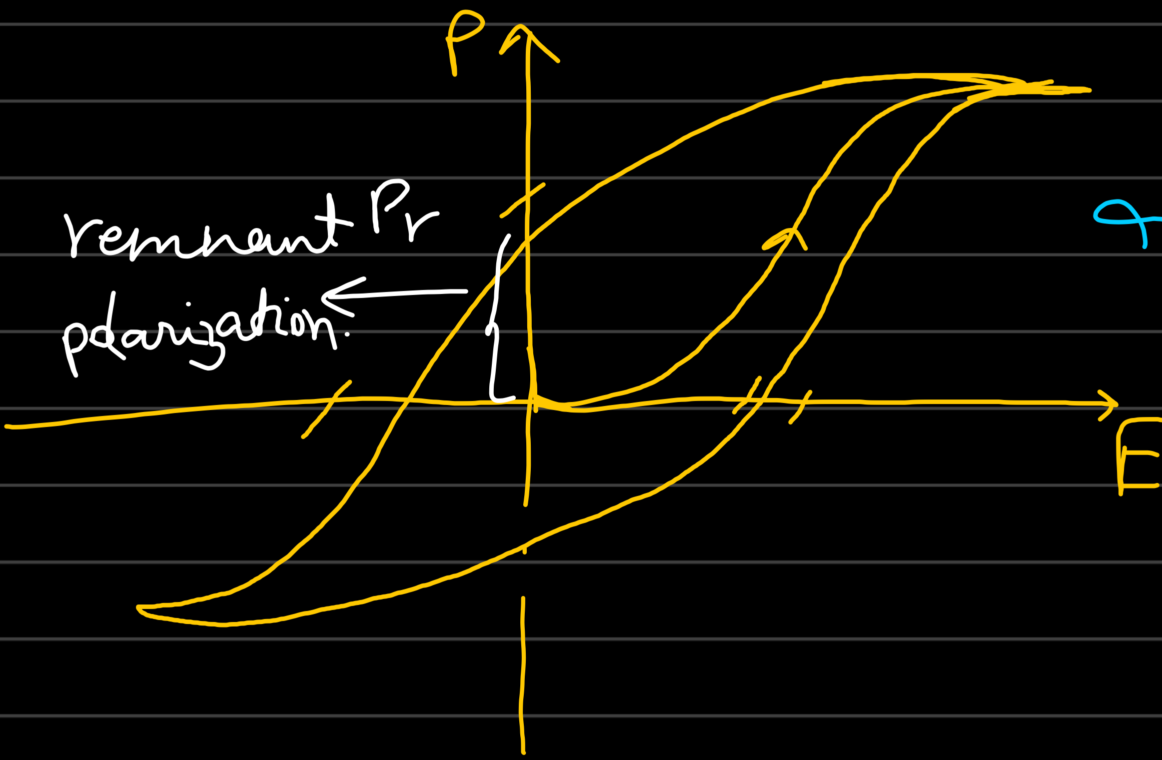
Lecture 30

Curie-Weiss Law:

↳ As temperature below T_c, polarizability tends to infinity.

α = polarizability ; P = polarization.

$$P = \alpha E$$

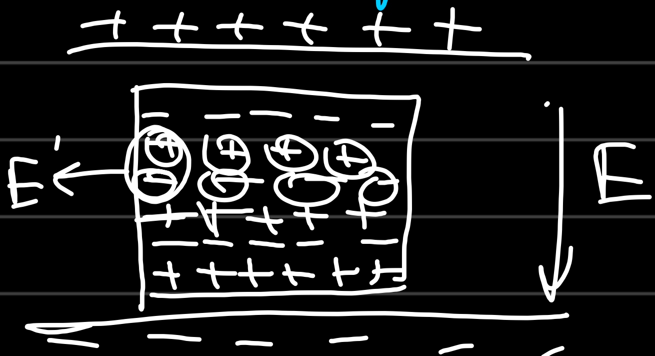


$P_r = \alpha E$

$\alpha \to \infty$, $E \to 0$

Local electric field in the presence of polarization.

$$E' = E + \frac{P}{3\varepsilon_0}$$

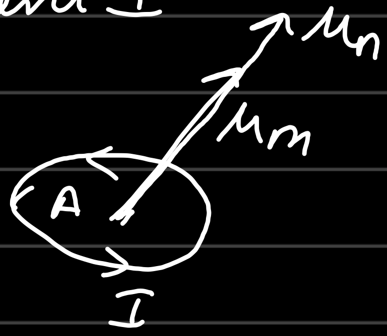


Magnetism

Magnetic Moment:

A circular coil carrying current I enclosing an area A.

$$\boxed{\mu_m = I A \mu_n}$$



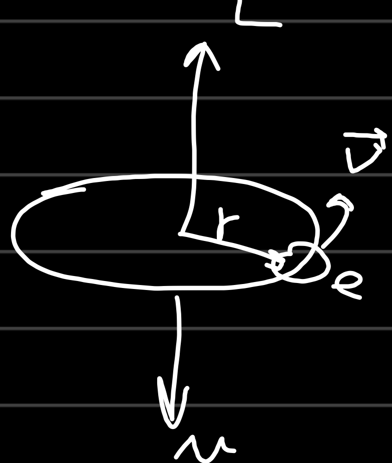
Magnetic field: $\boxed{F = q(\vec{v} \times \vec{B})}$

Magnetic momentum in an atom:

↳ Orbital magnetic mmt

Spin magnetic mmt

Orbital Magnetic momentum:



A current $I = -\dfrac{e}{T} = -\dfrac{e\omega}{2\pi}$

magnetic momentum for single electron $\mu_m = I\pi r^2 = -\dfrac{e\omega r^2}{2}$ {Classical}

Angular momentum: $L = m_e v r = m_e \omega r^2$ {Quantum}

$$\therefore \boxed{\mu_m = \frac{-e}{2m_e} L}$$

Precession of dipole moment:

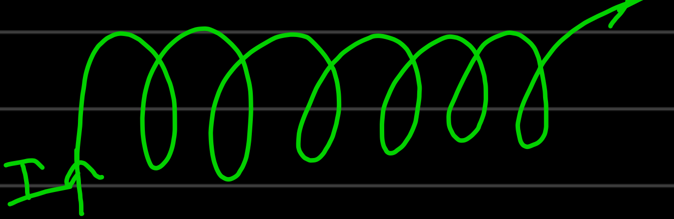
↳ a magnetic moment shall rotate about magnetic field.

↳ magnetic moment cannot align completely with field.

$$\tau = \frac{dL}{dt} = (\mu \times B)$$

Are atoms intrinsically magnetic:

↳ In closed shells, for every electron with $L! = 0$. For every m_e there is an opposite $-m_e$ There net magnetic moment is zero.



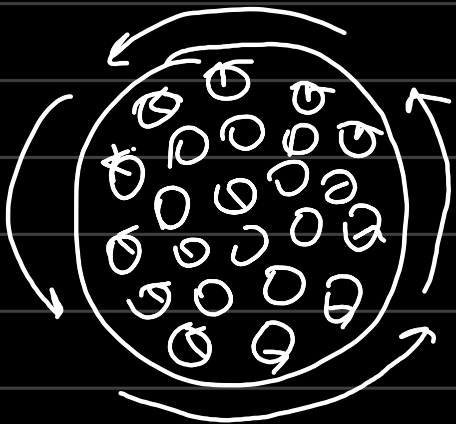
The magnetic field in center of solenoid $\boxed{B = \mu_0 n I}$

→ Each atom in material, if having unfilled shells develops a magnetic moment.

The net magnetic moment along the applied field (magnetization):

$$\boxed{M = \frac{1}{\Delta V} \sum \mu_m}$$

* The net magnetization leads to a non-zero surface current.
  ↳ Currents at the surface are not cancelled



Magnetization due to Atomic Loops:

Total Magnetization: $M \times A \times L$ ↓ magnetic dipole moment per unit volume.

$\mu = M \times A \times L$; $\mu = I \times A$

$= I_m \times A \times L =$

$\therefore \boxed{M = I_m}$

magnetic dipole per unit volume

surface current per unit length

The magnetic field at the center of coil is

$B = \mu_0 n I$;

when there is a material, probable magnetization.

$$B = \mu_0 n I + \mu_0 I_m$$

$$\boxed{B = B_0 + \mu_0 M}$$

H = Magnetizing field intensity.

$$H = \frac{B_0}{\mu_0} = nI$$