Physics 114 - March 21, 2006

Welcome Back

- **Exam 2** March 28 0800 ~~HST~~ Hubbell
- Project Posters April 7
  3-5 Hirst Lounge
- in-class presentations
  April 11 or 13
  Contact me - first come first served

Exam 2

Q+A session

- Sunday 26
  or
- Mon 27th
  ↳ would have to start at 3:30

Formula sheet, Material covered, LAS

Last Time

$$\vec{F} = q\vec{v} \times \vec{B}$$

Force on charge moving in Magnetic field

$$\vec{F} = i\vec{L} \times \vec{B} \quad \text{or} \quad L\vec{i} \times \vec{B} \quad \text{or} \quad Li\,\hat{i} \times \vec{B}$$

Force on a current carrying wire in a magnetic field

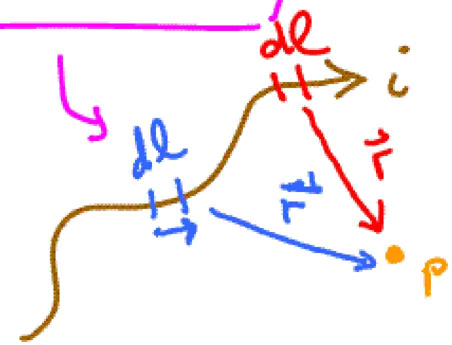
Versions of Right hand rule

visions of Patty Ellen

Law of Biot-Savart

For Point charge

For current



$$\vec{B}_{\text{at } P \text{ due to } q} = \frac{\mu_0}{4\pi} \frac{q\vec{V} \times \hat{r}}{r^2}$$

$$B_{\text{at } P \text{ due to } i} = \frac{\mu_0}{4\pi} \int \frac{i\,d\vec{l} \times \hat{r}}{r^2}$$

Current distribution

Important

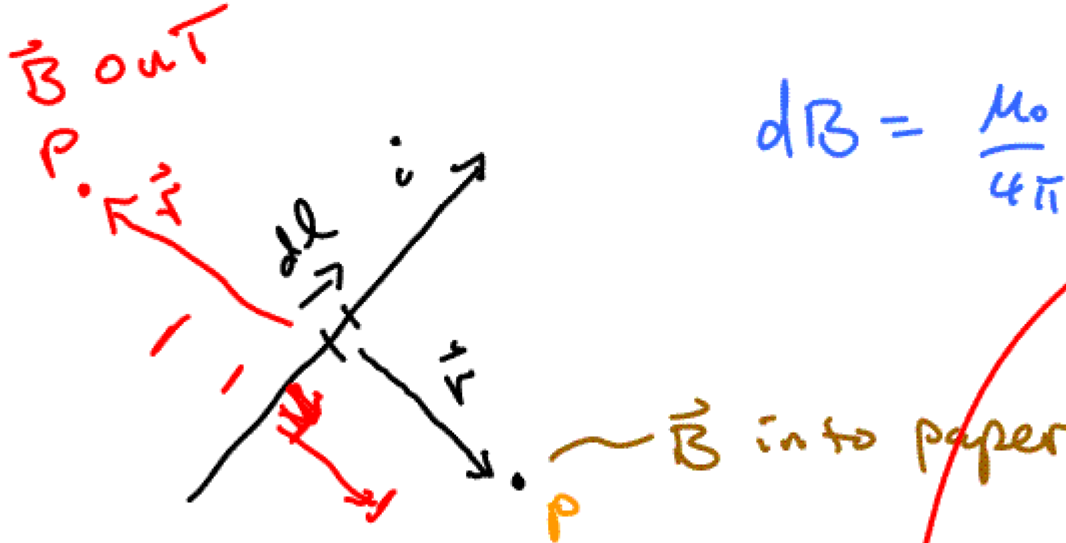
$\mu_0 \equiv$ const $\equiv$ Permeability of free Space

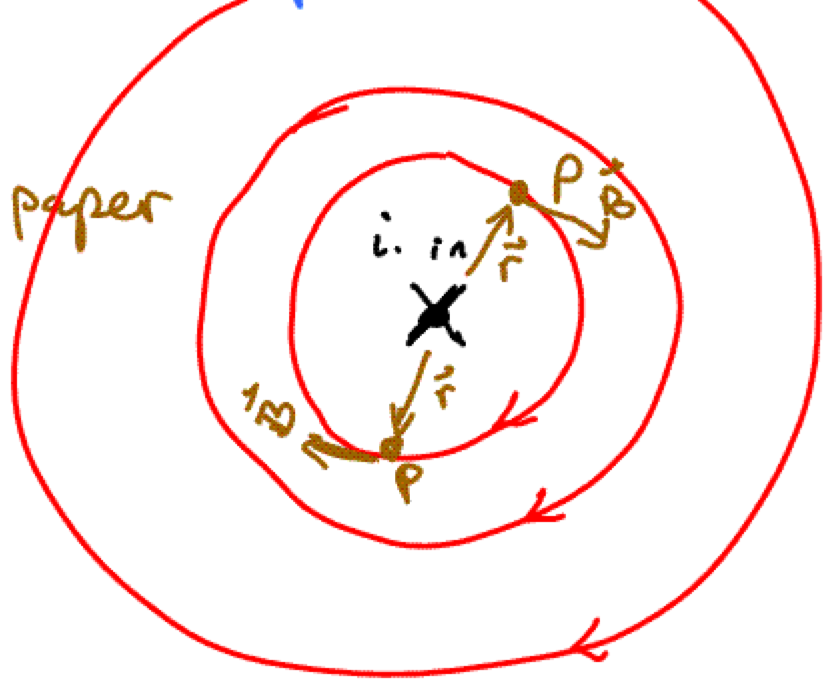
$= 4\pi \times 10^{-7} \frac{T \cdot M}{A}$

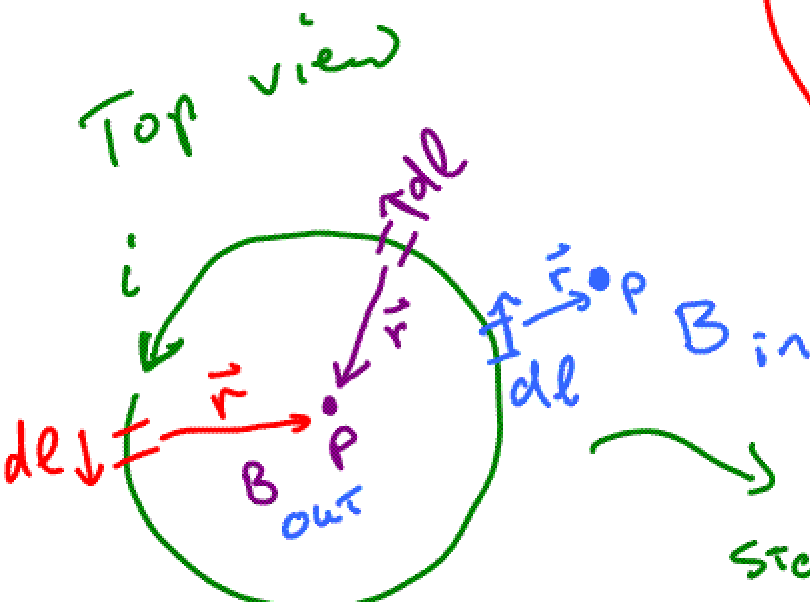
Let's get the directions down first!

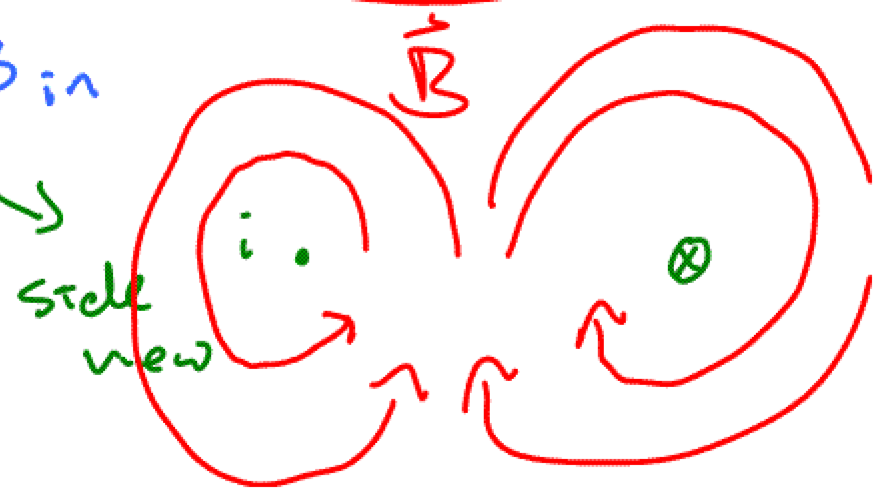
$\rightarrow$ Those <u>other</u> Right hand Rules

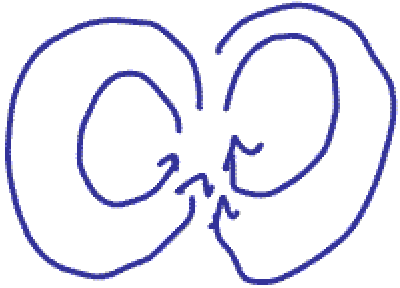
$$dB = \frac{\mu_0}{4\pi} \frac{i\, d\vec{l} \times \hat{r}}{r^2}$$







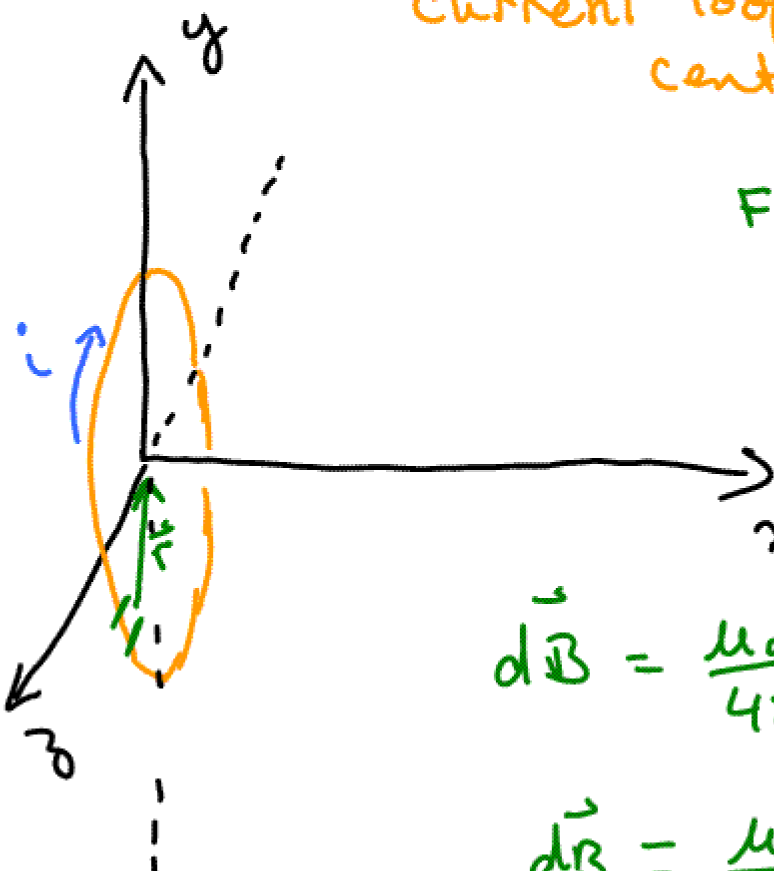




Field surrounding current loop

→ Magnetic dipole field

circular current loop in y-z plane centered at origin



Find $\vec{B}$ at origin

By RHR

$\vec{B}$ direction

↳ $-\hat{x}$

$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{i\,d\vec{l}\times\hat{r}}{r^2}(-\hat{x})$$

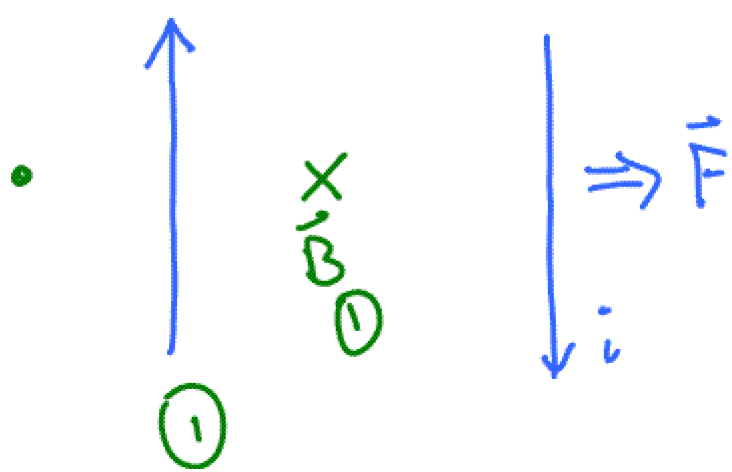
$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{i\,dl}{r^2}(-\hat{x})$$

$r,\ 4\pi,\ \mu_0,\ i \equiv \text{const}$

$$\vec{B} = \frac{\mu_0}{4\pi}\frac{i}{r^2}(-\hat{x})\int dl$$

$$\vec{B} = \frac{\mu_0}{4\pi}\frac{i}{r^2}\,2\pi r(-\hat{x})$$

$$= \frac{\mu_0 i}{2r}(-\hat{x})$$



Electrostatics

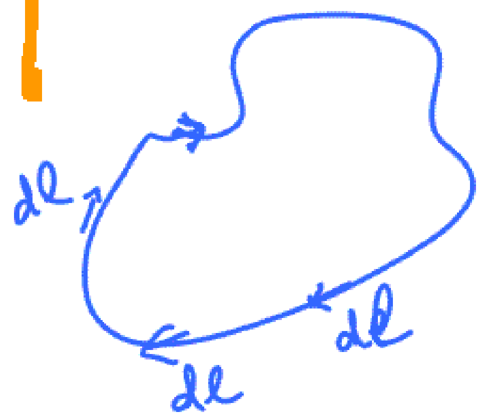
Gauss' law

$$\int_{\text{surf}} \vec{E} \cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

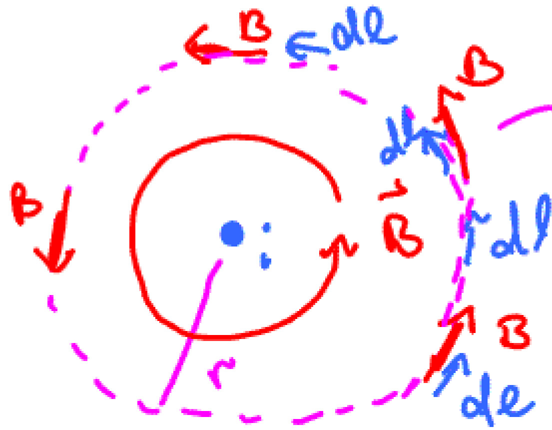
Magnetostatics

Ampere's law

$$\int_{\substack{\text{closed}\\ \text{curve}}} \vec{B} \cdot d\vec{l} = \mu_0 I_{enclosed}$$



useful for cylindrical symmetry



$$\oint_{loop} \vec{B} \cdot \vec{dl} = \mu_0 I_{encl}$$

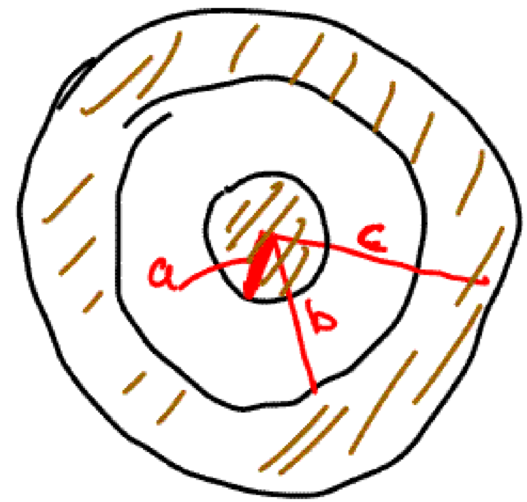
$$\int_0^{2\pi r} B\,dl = \mu_0 I_{encl}$$

$$B\,2\pi r = \mu_0 i$$

$$B = \frac{\mu_0 i}{2\pi r}$$

I distributed evenly in conductors

I uniform



Find $\vec{B}$ in all space

$r < a$

I out

$$\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I_{encl.}$$

$\vec{j} \equiv$ current density

$$\vec{j} = \frac{I}{\pi a^2}$$

B fn of r

cylindrical sym

RHR → counter clockwise

$$\int \vec{B} \cdot dl = |\vec{B}| 2\pi r = \mu_0 \; j \underbrace{\pi r^2}$$

Area of Amperian loop

$$|\vec{B}| = \mu_0 \frac{I}{\pi a^2} \frac{\pi r^2}{2\pi r}$$

$$|\vec{B}| = \frac{\mu_0 r I}{2\pi a^2} \quad \text{for } r < a$$

Will look at $a < r < b$ and $b < r < c$

and $r > c$

regions at start of

Next class.