Physics 142 - October 23, 2008

- Presentation groups set up
  - see web

Last Time

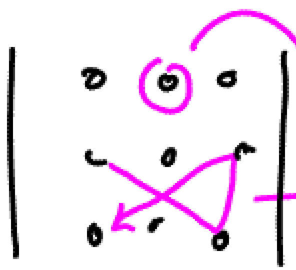
Lorentz Force law

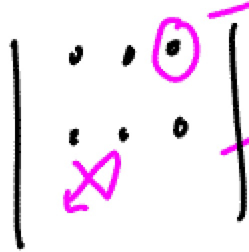
$$\vec{F} = q\vec{E} + q\vec{v}\times\vec{B}$$

$$\vec{F}_{wire} = L\vec{i}\times\vec{B} \quad \text{or} \quad i\vec{L}\times\vec{B}$$

Evaluation of cross product

$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} = \hat{i}\,(A_y B_z - A_z B_y) - \hat{j}\,(A_x B_z - A_z B_x) + \hat{k}\,(A_x B_y - A_y B_x)$$

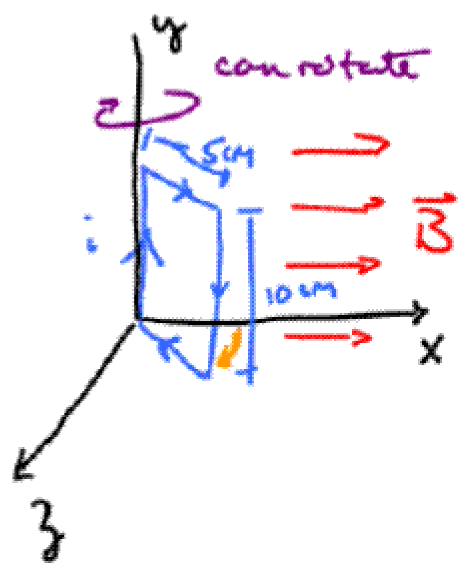


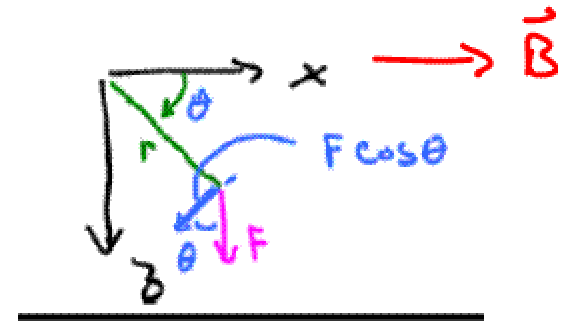


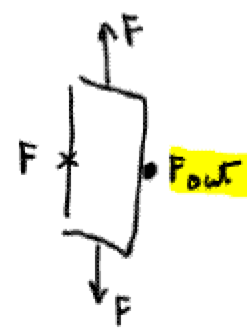
$$|\vec{A}\times\vec{B}| = |\vec{A}|\,|\vec{B}|\sin\theta$$

Current loop in $\vec{B}$ – what is torque about y axis?

observe from this pt of view → Project in x-z plane







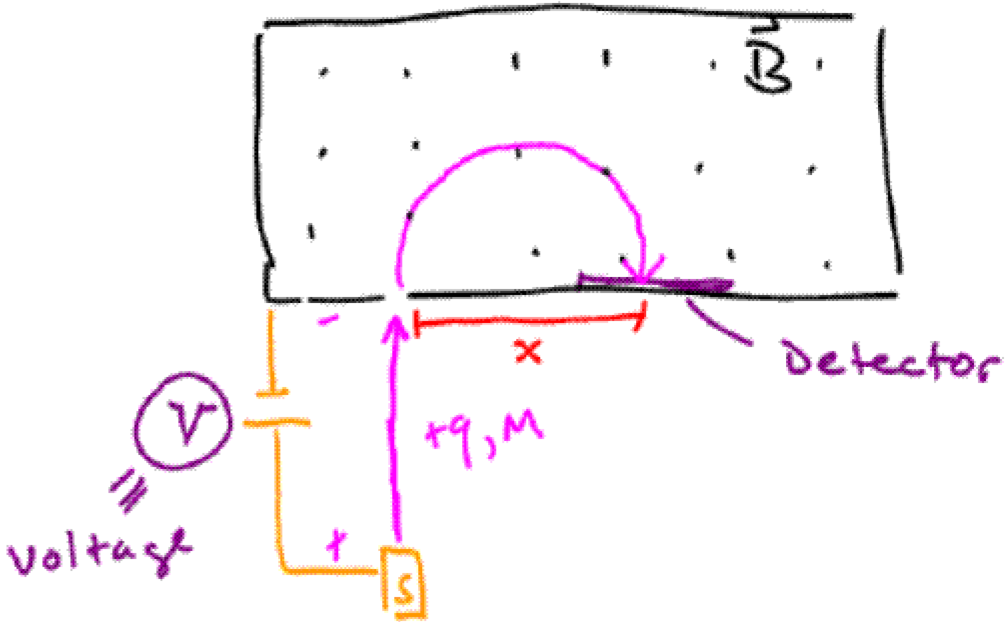
only force that matters for rotation about y

$$\vec{\tau} = \vec{r} \times \vec{F} = (5\,cm)\,|F|\cos\theta\,(-\hat{y})$$

↑

$$iLB = (10\,cm)\,i\,B$$

Mass Spectrometer



V = velocity

$F = qvB \qquad F = \frac{mv^2}{R}$

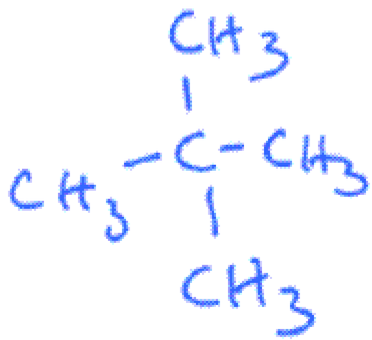
$qvB = \frac{mv^2}{R} \qquad m = \frac{qRB}{v}$

$KE = +q|e|V = \frac{1}{2}mv^2$

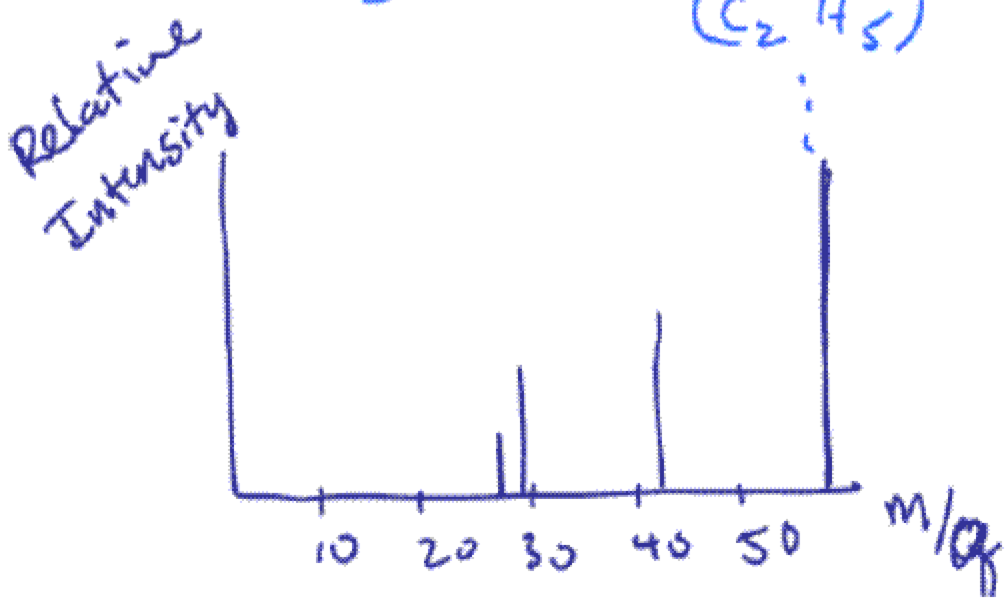
$$v = \left(\frac{2qV}{m}\right)^{1/2}$$

$$x = 2R$$

$$m = \frac{|e|q R^2 B^2}{2V} = \frac{|e|q B^2 x^2}{8V}$$

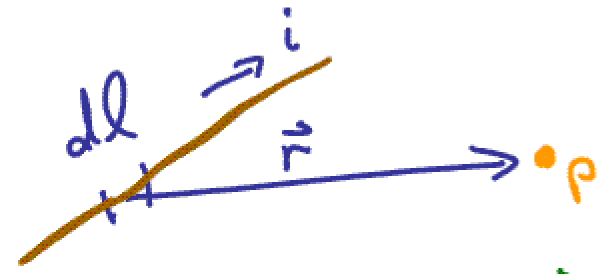


	m/q	Rel int.
$(C_4H_9)^+$	57	100
$(C_3H_5)^+$	41	41.5
$(C_2H_5)^+$	29	38.5
⋮	⋮	⋮



Law of Biot-Savart

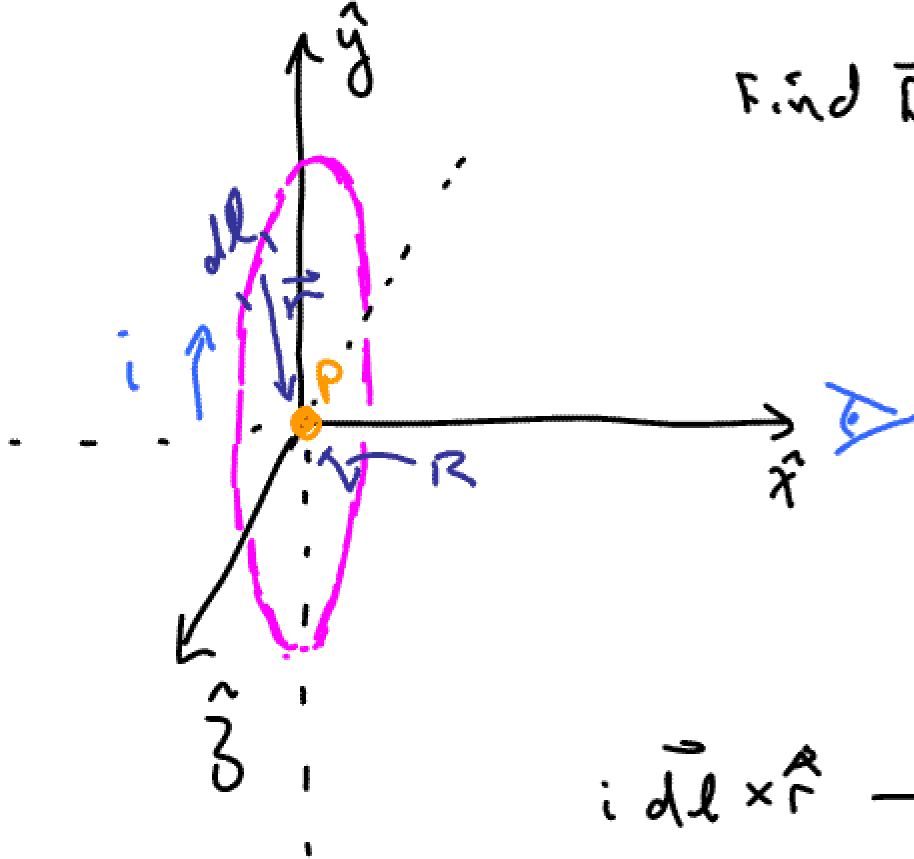
Learn to visualize Field thru this



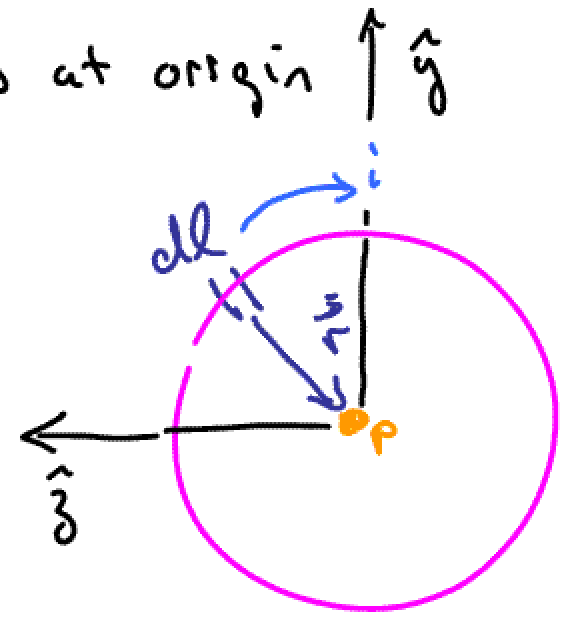
$$d\vec{B}_P = \frac{\mu_0}{4\pi} \frac{i\, d\vec{l} \times \hat{r}}{r^2}$$

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

current distribution



Find $\vec{B}$ at origin



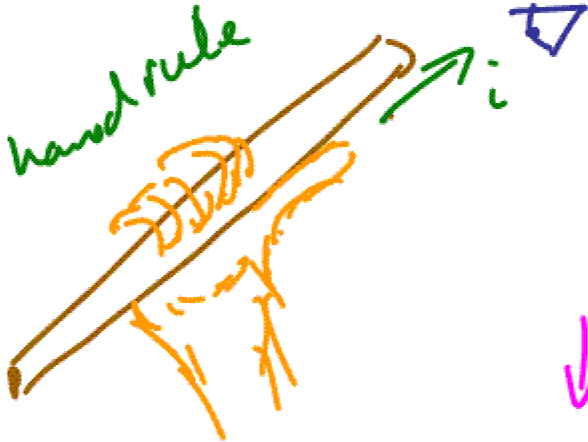
$i\,\vec{d\ell} \times \hat{r} \longrightarrow$ in $-\hat{x}$ direction

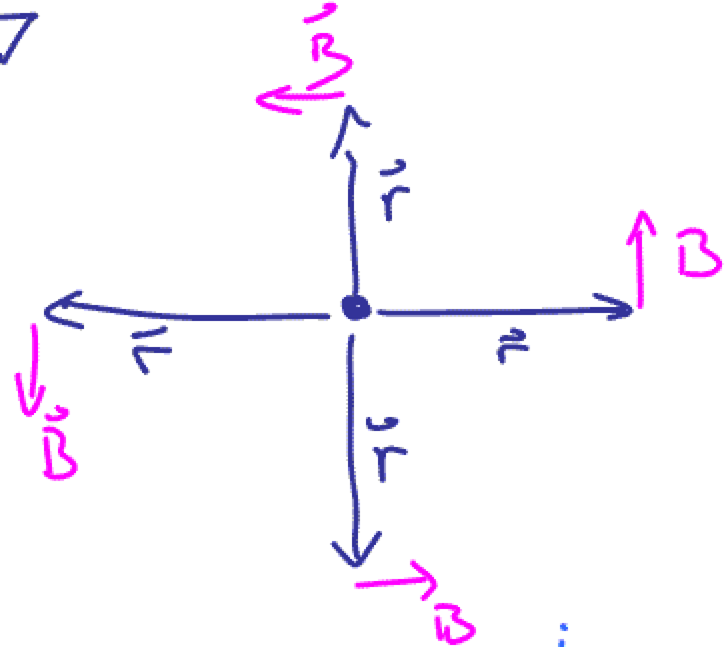
$\vec{B}$ at P is in $-\hat{x}$

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

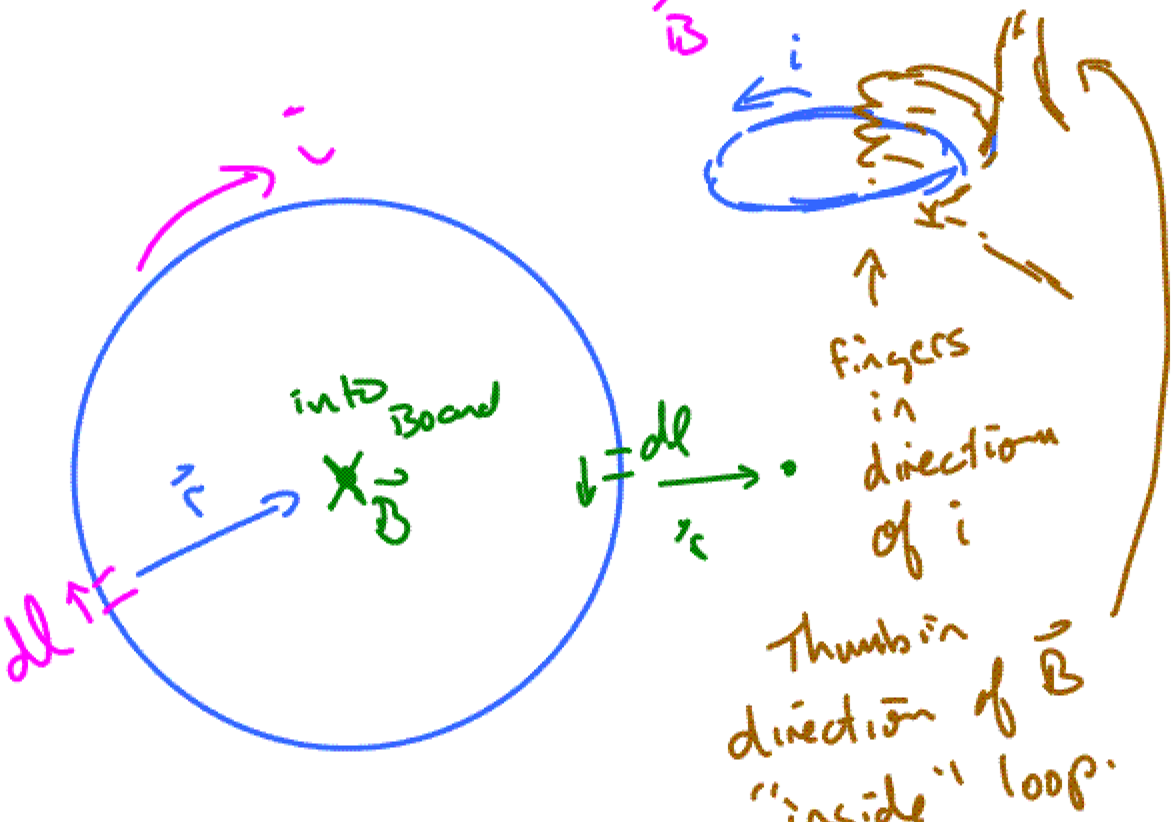
$$\vec{B} = \frac{\mu_0}{4\pi}\frac{i}{R^2}(-\hat{x})\int_0^{2\pi R} ds = \frac{\mu_0 i}{2R}(-\hat{x})$$

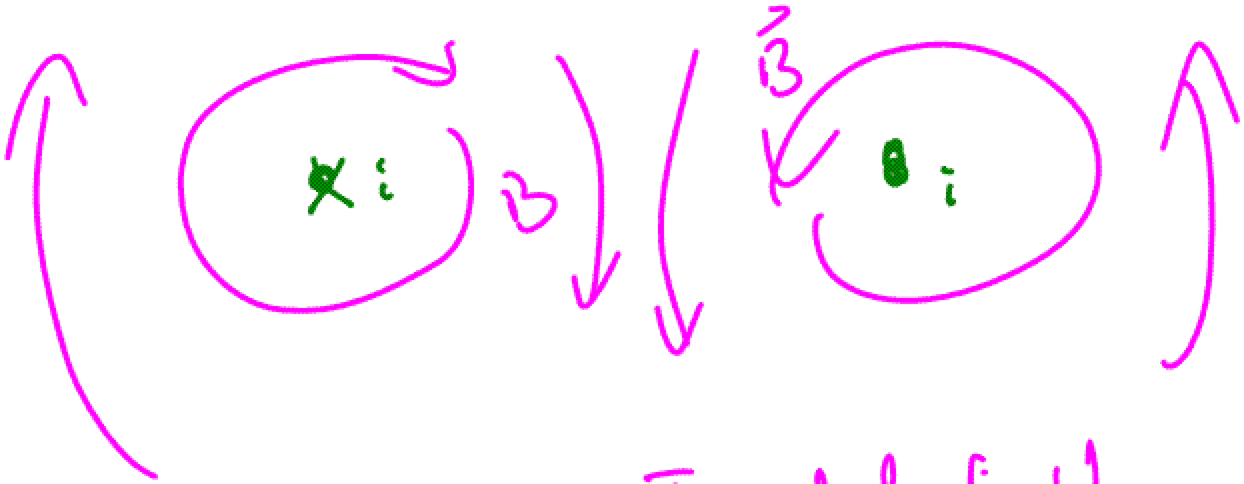
Another Right hand rule





... and Another





Electrostatics

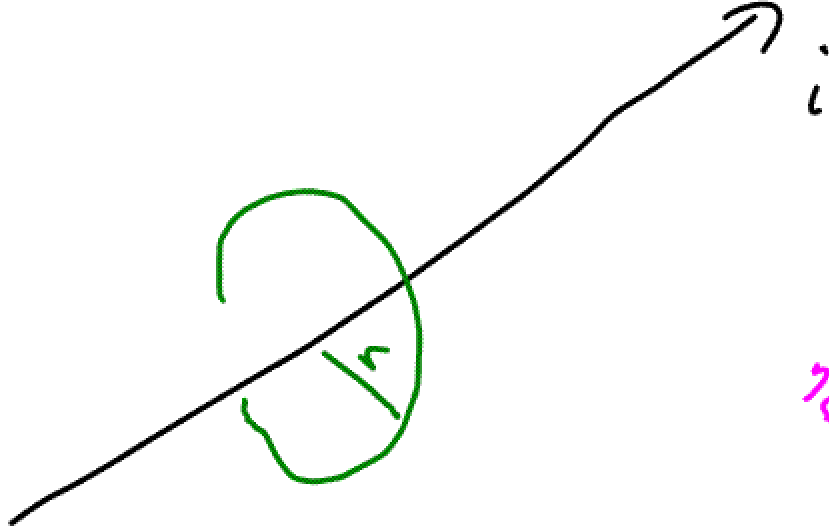
Gauss' law

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

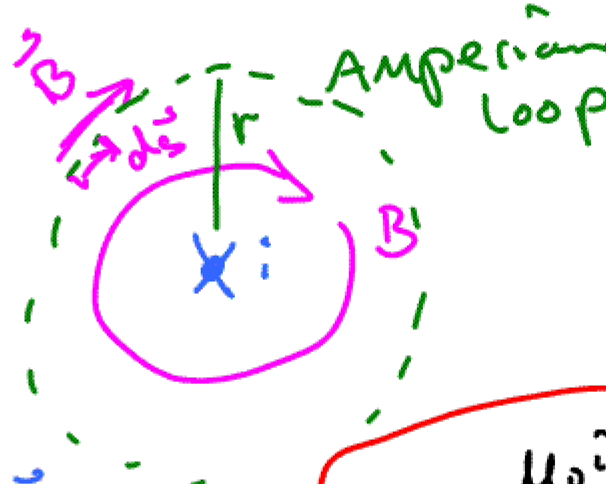
magnetostatics

Ampere's law

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



$\vec{B}$ only radial dependence



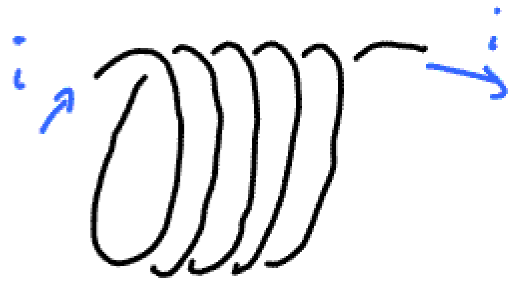
Biot-Savart $\quad B \sim \dfrac{i\, d\vec{l} \times \hat{r}}{r^2}$

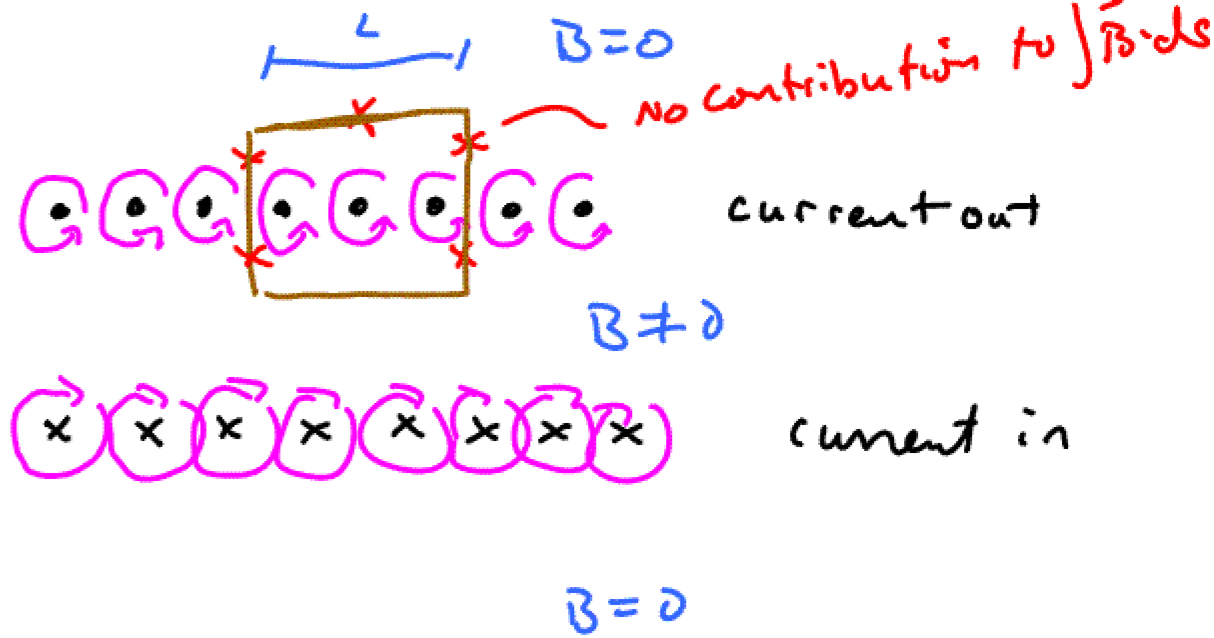
$$|\vec{B}| = \frac{\mu_0 i}{2\pi r}$$

$$\oint_{\text{closed loop}} \vec{B}\cdot d\vec{s} = \oint |\vec{B}|\, ds = |\vec{B}| \int_0^{2\pi r} ds = |\vec{B}|\, 2\pi r = \mu_0 i$$

Field of ∞ Solenoid

n loops/unit length





$$\int \vec{B}\cdot\vec{ds} = |\vec{B}|\,L = \mu_0 \underbrace{i_{encl}}_{nL}$$

$$|\vec{B}| = \mu_0 n i$$