Physics 114 – March 23, 2006

Exam 2 → Hubbell Auditorium

March 28 at 0800

NOT Hoyt as stated on Tuesday

Review session → Sunday 4 – 5:30

B+L 109

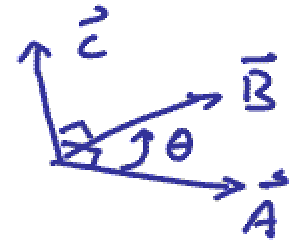
Right Hand Rules

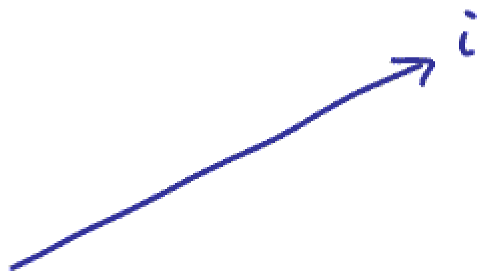
1. direction of cross product

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

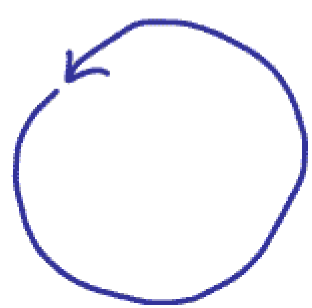
$$F = i\,\vec{L} \times \vec{B}$$

$$\vec{A} \times \vec{B} = \vec{C}$$



2. 

direction of $\vec{B}$ surrounding current-carrying wire

3. 

Direction of $\vec{B}$ inside current-carrying loop

Biot-Savart:
[redacted]

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

Ampere's Law:
[redacted]

$$\int \vec{E} \cdot d\vec{l} = \mu_0 I_{enclosed}$$

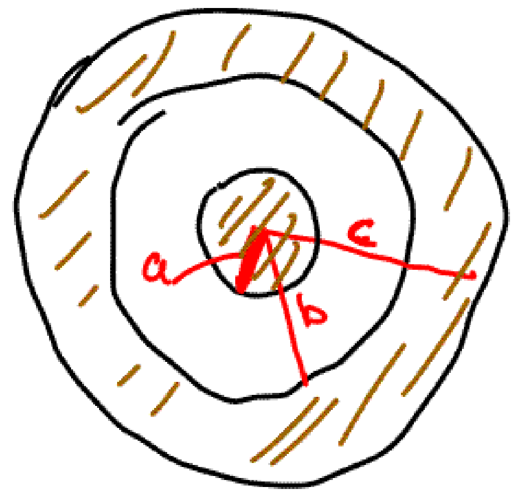
Both eqns <u>always</u> hold true

Ampere's Law is particularly useful under certain conditions of symmetry and choice of Amperian loop so that

$$\int_{loop} \vec{B} \cdot d\vec{l}$$ is simple to calculate

I distributed evenly in conductors

I uniform



Find $\vec{B}$ in all space

$r<a$

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

$\vec{j}$ = current density

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

B fn of r

cylindrical sym

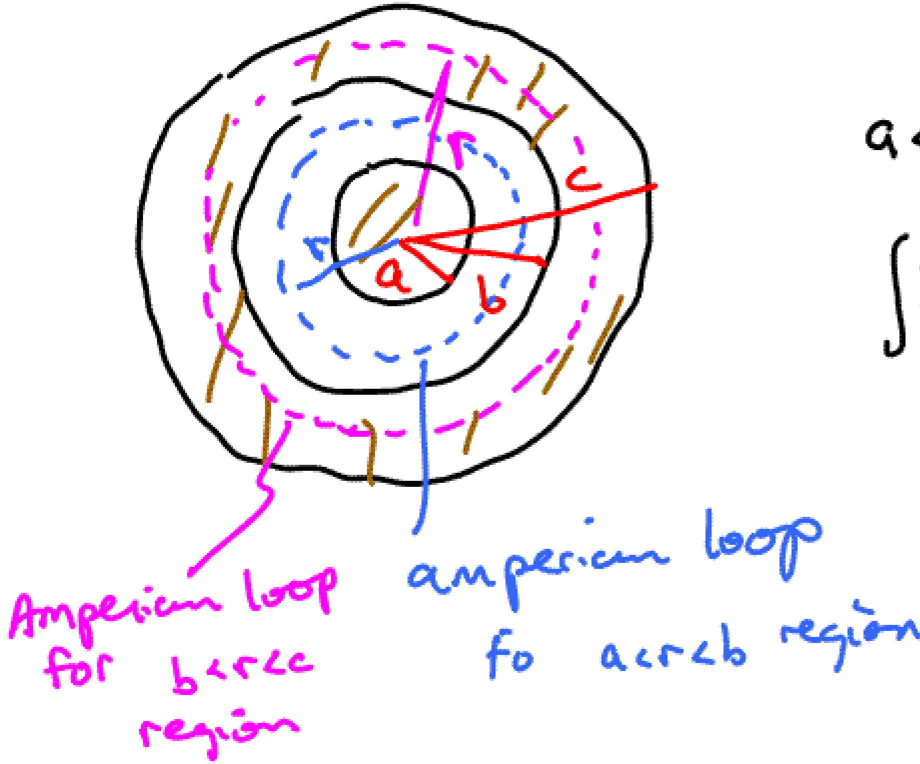
RHR → counter clockwise

$$\int \vec{B} \cdot d\ell = |\vec{B}| 2\pi r = \mu_0 \, j \underbrace{\pi r^2}_{\text{Area of Amperean loop}}$$

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

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

Will look at $a<r<b$ and $b<r<c$
and $r>c$
regions at start of
Next class.



a<r<b

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

$$|\vec{B}| \int d\ell = \mu_0 I_{encl}$$

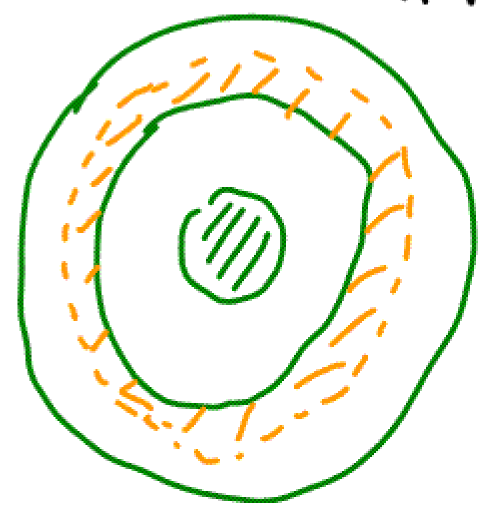
$$|\vec{B}| \, 2\pi r = \mu_0 I_{encl}$$

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

b<r<c

$$\int B \cdot d\ell = \mu_0 I_{encl}$$

$$|\vec{B}| \, 2\pi r = \mu_0 I_{encl}$$



outer conductor $|\vec{j}|_{outer} = \dfrac{I}{\pi c^2 - \pi b^2}$

$$I_{encl} = I_{inner} - \vec{j}_{outer}(\pi r^2 - \pi b^2)$$

Area of outer conductor enclosed by loop

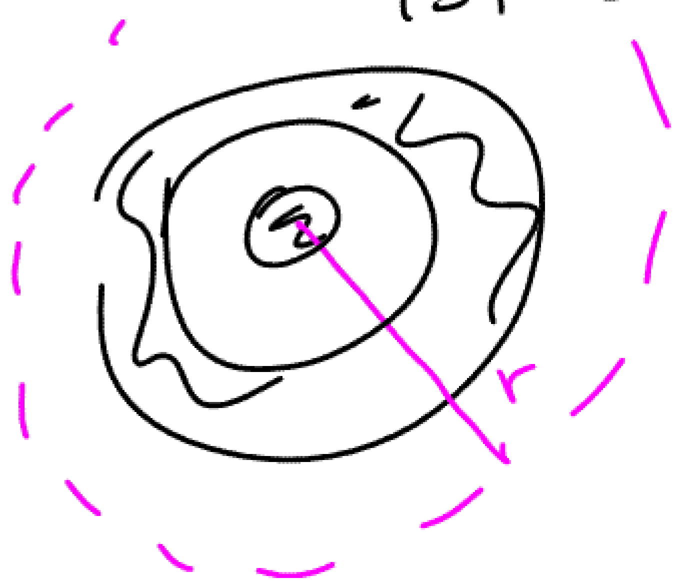
$$I_{enc} = I - \frac{I(\pi r^2 - \pi b^2)}{(\pi c^2 - \pi b^2)}$$

$$I_{enc} = I\left(1 - \frac{r^2 - b^2}{c^2 - b^2}\right)$$

$$|\vec{B}| = \frac{\mu_0 I \left(1 - \frac{r^2 - b^2}{c^2 - b^2}\right)}{2\pi r}$$

$r > c$

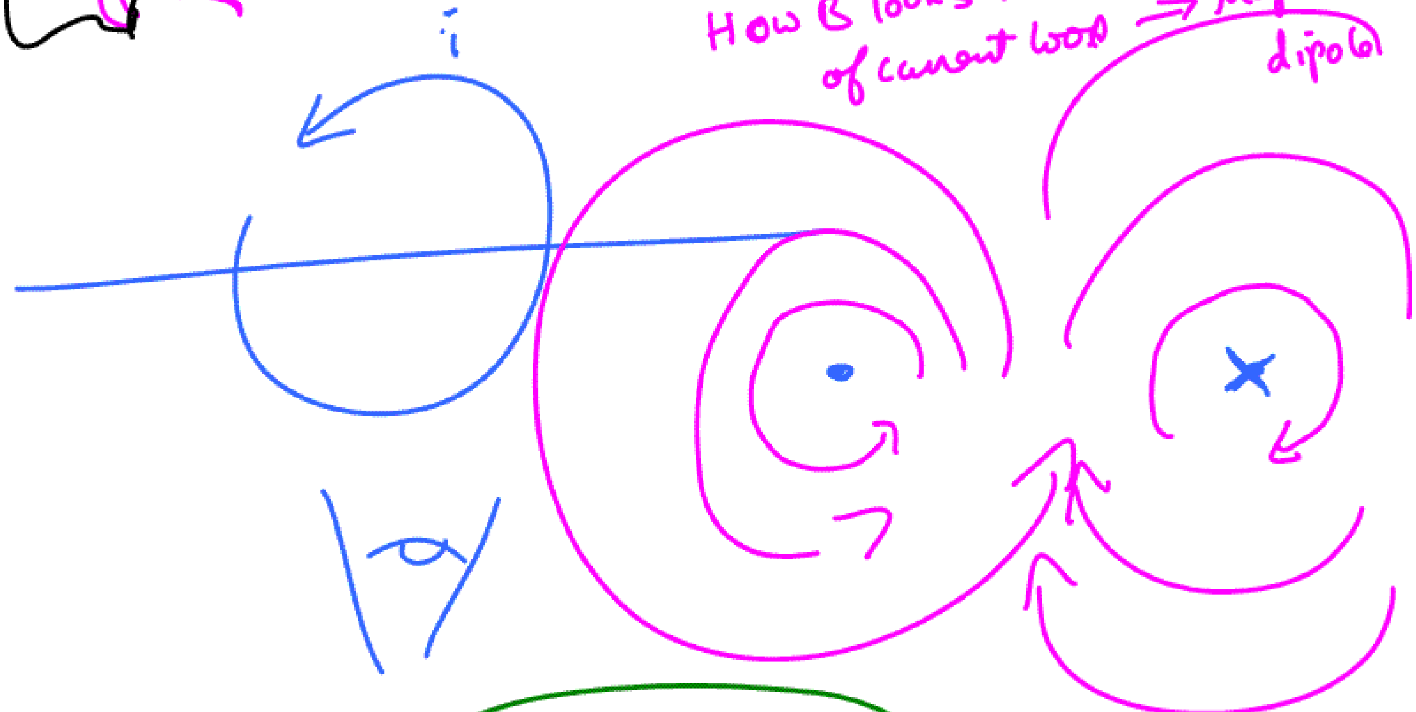
$|B| = 0$

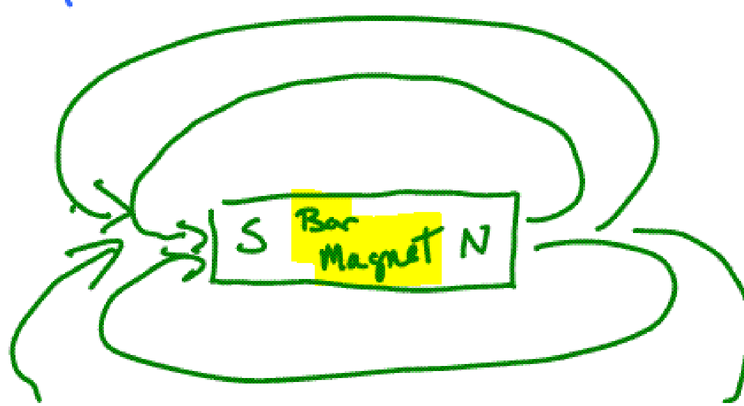


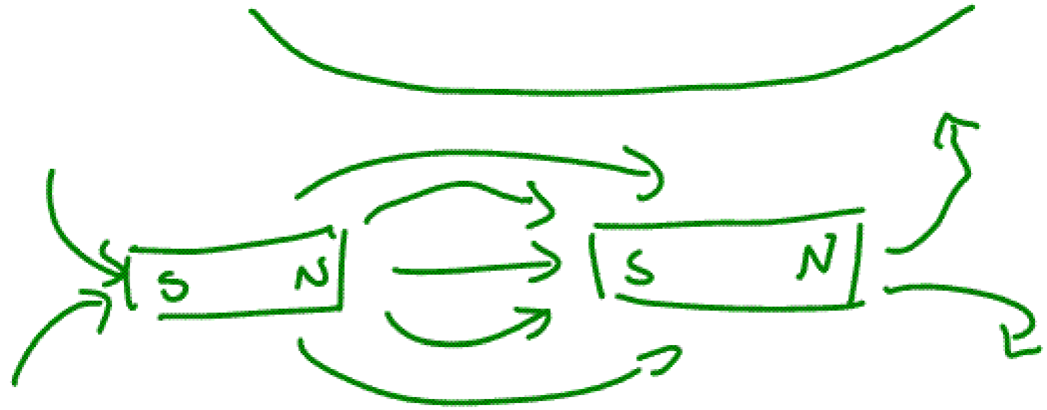
$$\int B \cdot dl = \mu_0 I_{encl}$$

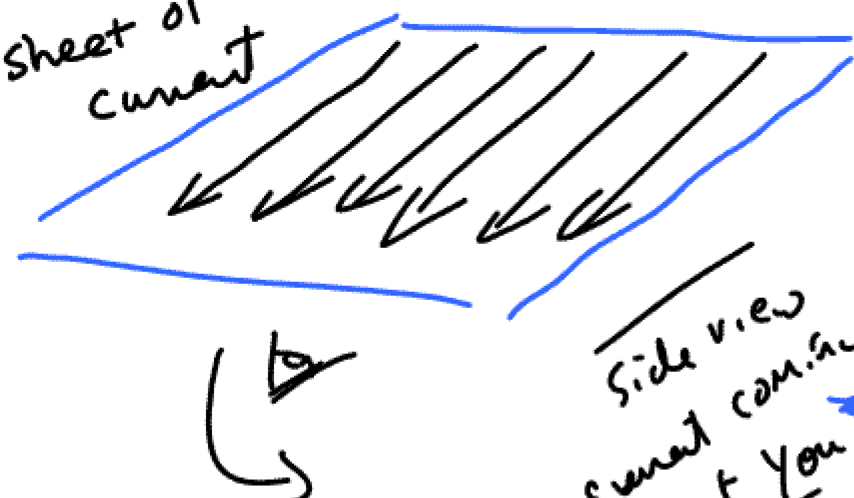
$$|B| = 0$$

How $\vec{B}$ looks from side of current loop → magnetic dipole



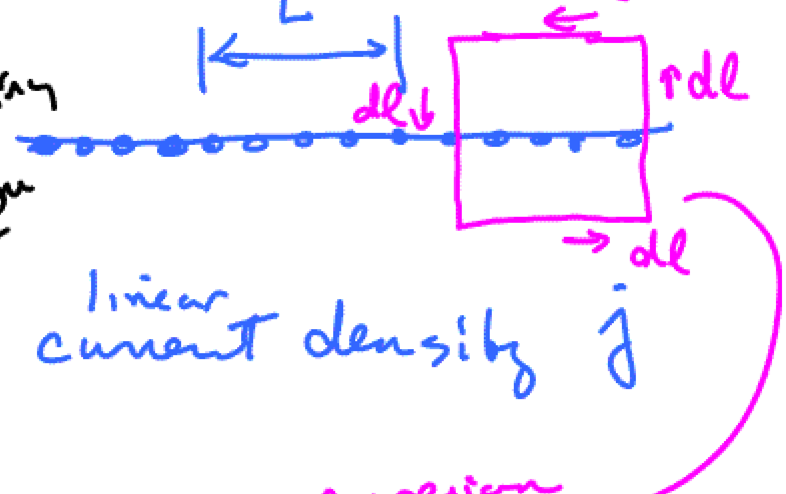






side view
current coming at you

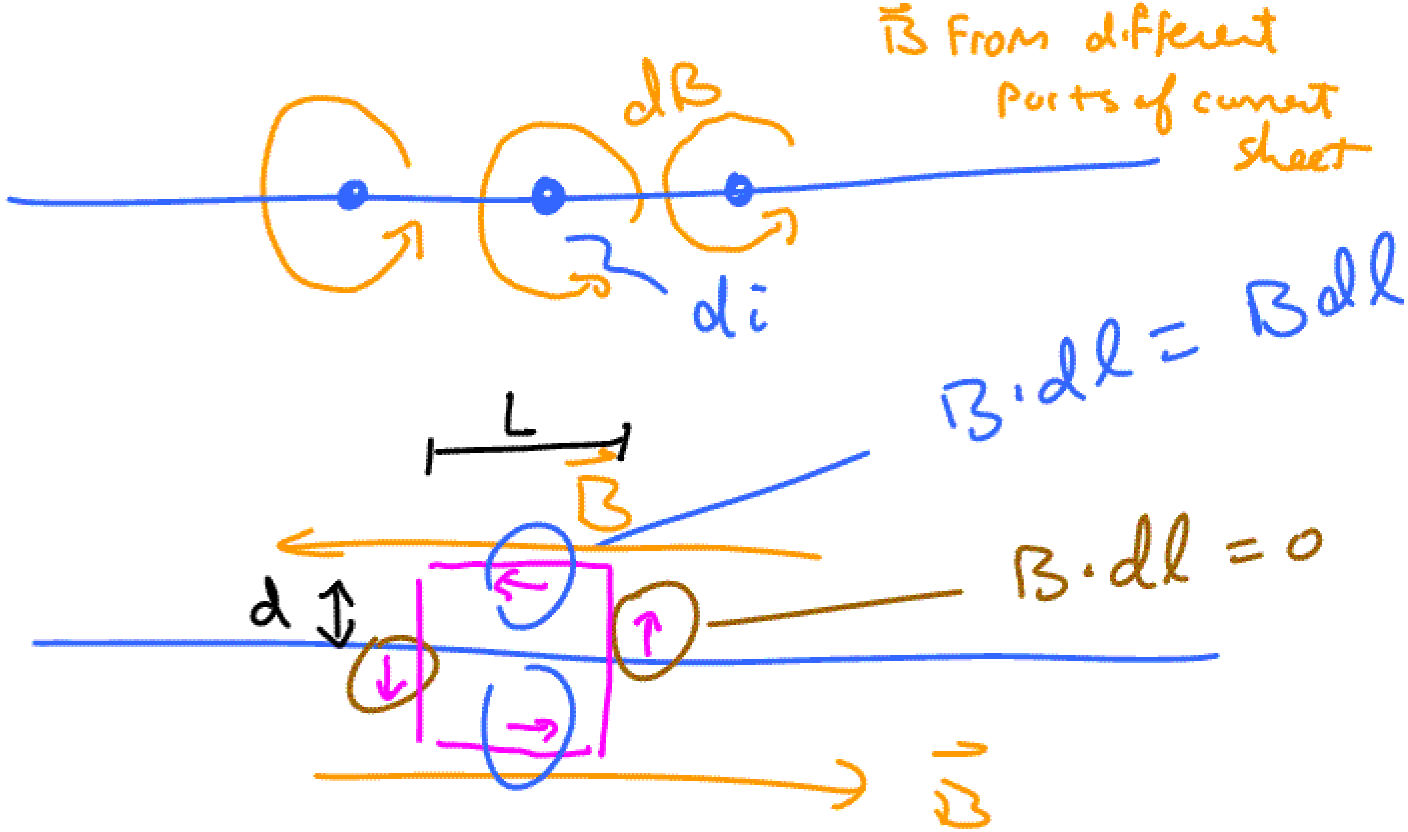
$I_{\text{within } L} = jL$



linear current density j

$$\int \vec{B} \cdot d\vec{l} = \mu_0 I_{encl}$$

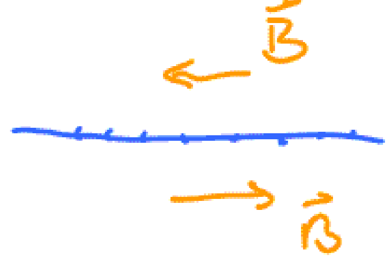
use Ampere's Law



$$\int B\cdot dl = 2|B|L = \mu_0 I_{encl}$$

$$|B|\int dl \qquad = \mu_0 j L$$

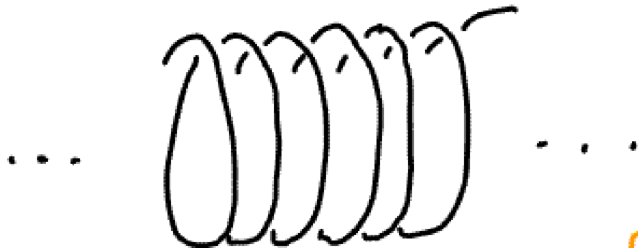
$$2|B|L = \mu_0 j L$$

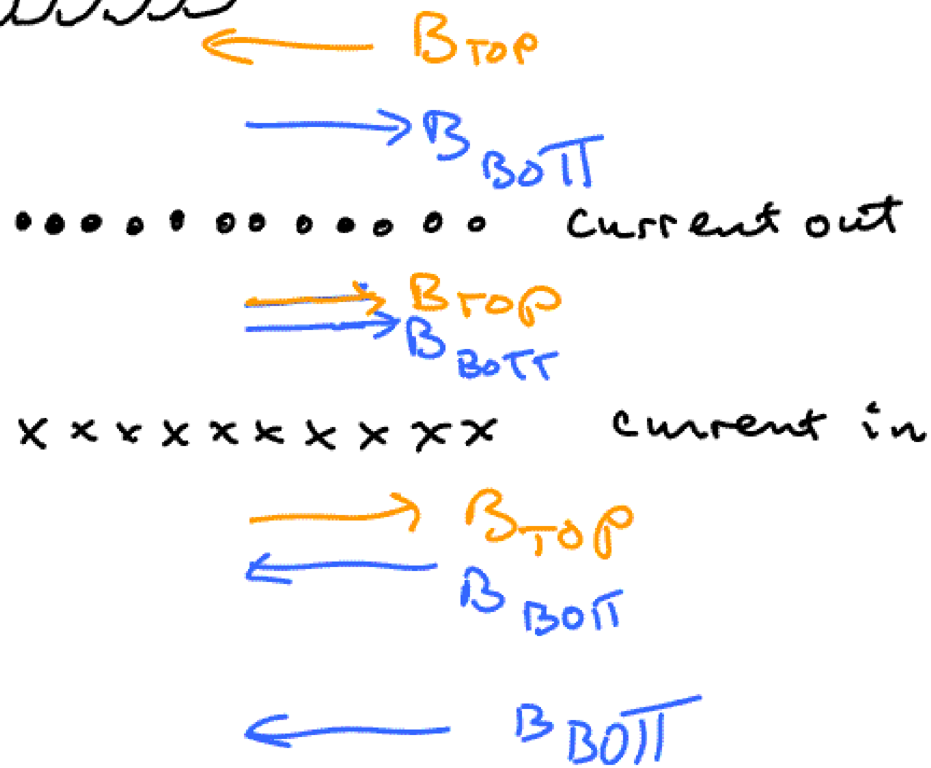


$$|B| = \frac{\mu_0 j}{2}$$

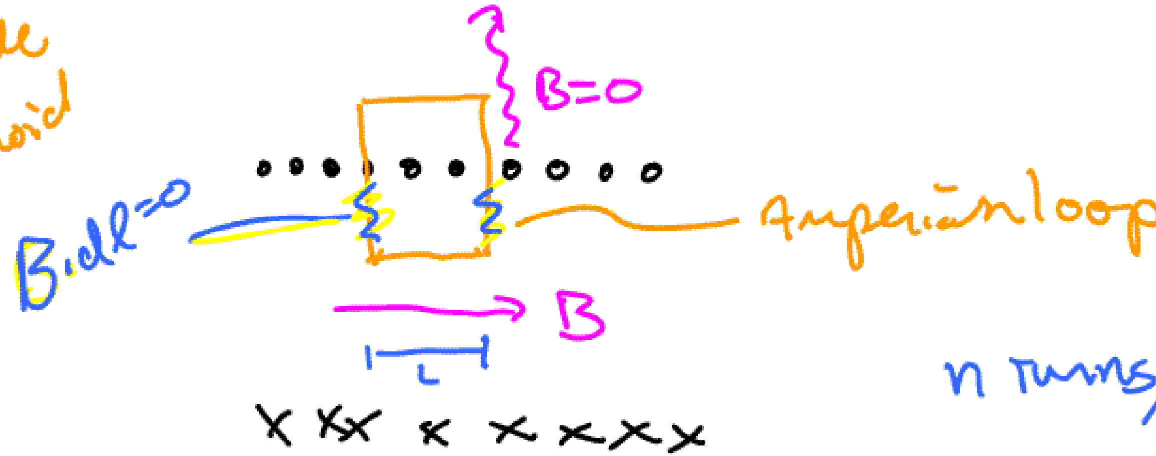
Infinite Solenoid

$\vec{B}$ field





What is B inside Solenoid



n turns/length

$$\oint \bar{B}\cdot d\bar{l} = BL = \mu_0 \underbrace{I_{encl}}_{i n L}$$

$$B = \mu_0 i n$$