Physics 114 - March 16, 2010

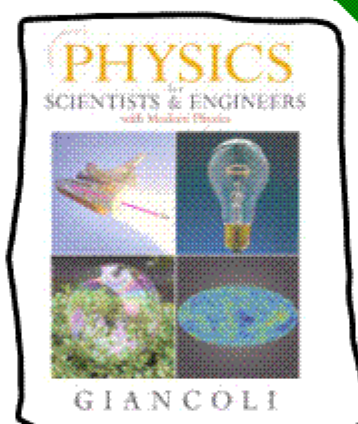
Welcome Back

Exam 2

Tues. March 23 0800

Hoyt ... Am requesting

Hubbell ... stay tuned



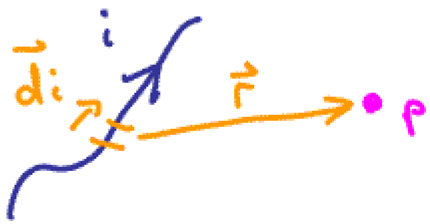
Q+A session

late Mon afternoon

Magnetism

$\vec F = q\,\vec v \times \vec B$ Force on moving charged particle

$\vec F = l\,\vec i \times \vec B$ Force on current-carrying wire



Biot-Savart

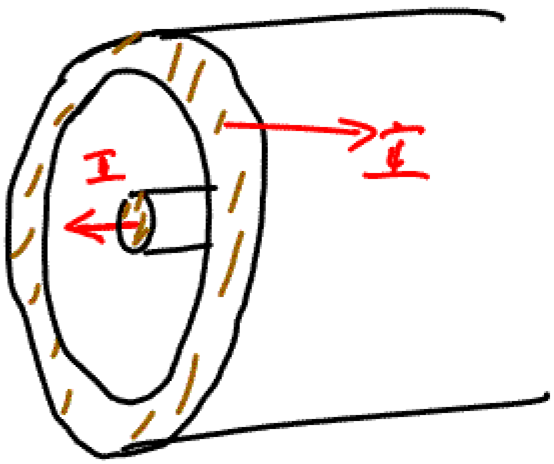
$$\vec B_p = \frac{\mu_0}{4\pi}\int_{\text{currents}} \frac{l\,d\vec i \times \hat r}{r^2} = \frac{\mu_0}{4\pi}\int_{\text{currents}} \frac{l\,d\vec i \times \vec r}{r^3}$$

Ampere's law

$$\oint_{\text{loop}} \vec B \cdot d\vec l = \mu_0 I_{encl}$$

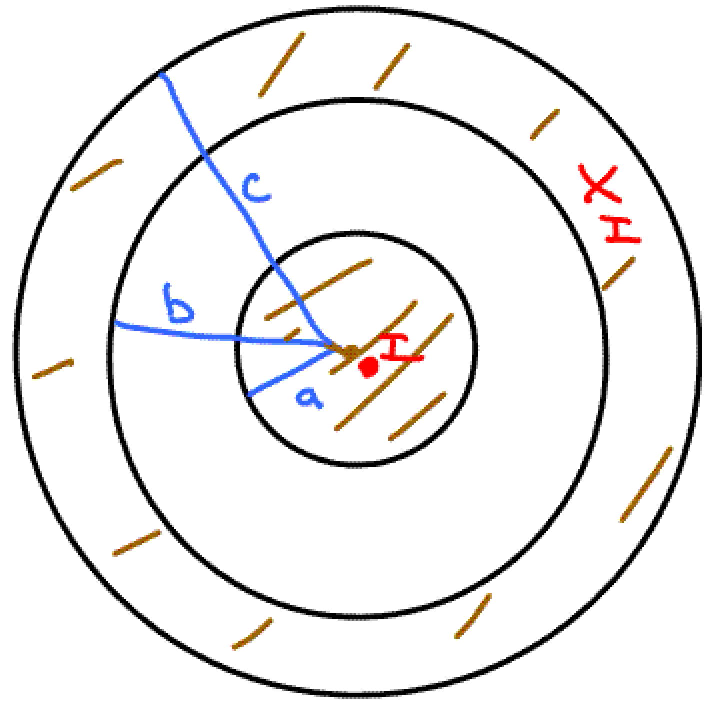
Useful for calc $\vec B$ under circumstances w/ proper symmetry

Coaxial cable (long)



Assume I is uniform across both inner + outer conductors.

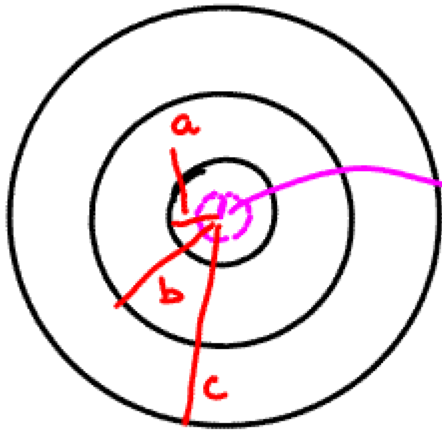
Find $\vec{B}$ in all space



use Ampere's law

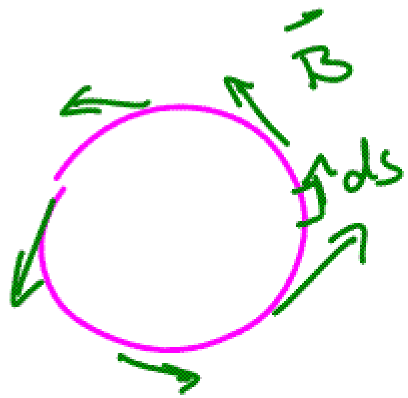
$$\int_{\text{curve}} \vec{B} \cdot d\vec{s} = \mu_0 I_{encl}$$

$r < a$



coaxial, circular
Amperian loop
radius $r < a$

$\perp$ To Axis



I is out

$$\oint \vec{B}\cdot d\vec{s} = |\vec{B}(r)| \int_0^{2\pi r} ds$$

LH side of Ampere's law

$$= |\vec{B}(r)|\, 2\pi r$$

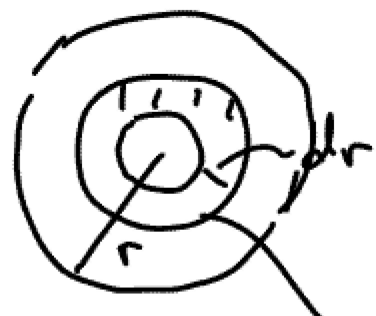
Right side of Ampere's law

I spread out

Amperian loop

$\vec{j}(r) \equiv$ current density $\equiv$ constant (special to this case)

$$j = \frac{I}{\pi a^2} \equiv \text{constant}$$



$$I_{encl} = \int j \, dA = \int_0^r j \, 2\pi r \, dr \qquad 2\pi r \, dr = dA$$

in this case j is constant ... But could be $j(r)$ and would have to stay in integral

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

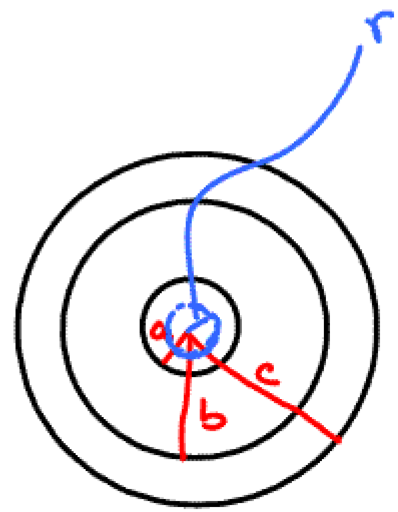
$$I_{encl} = I \, r^2 / a^2$$

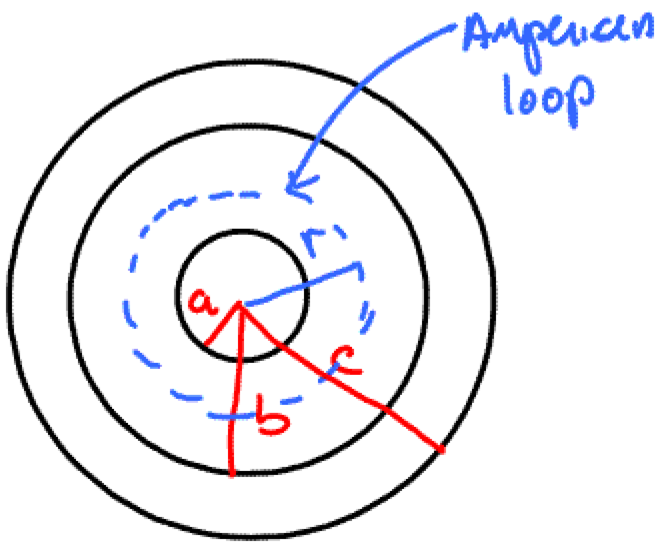
$$I_{\substack{encl \\ r<a}} = j\pi r^2 = \frac{I}{\pi a^2}\pi r^2 = I\frac{r^2}{a^2}$$

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

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

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



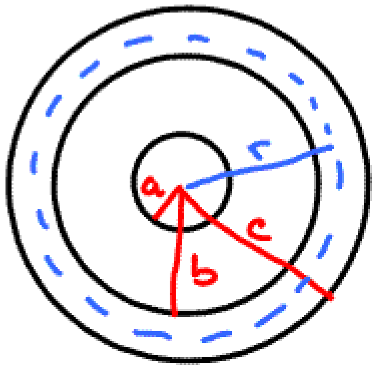


$b > r > a$

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

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

$$|\vec{B}|_{b>r>a} = \frac{\mu_0 I}{2\pi r}$$



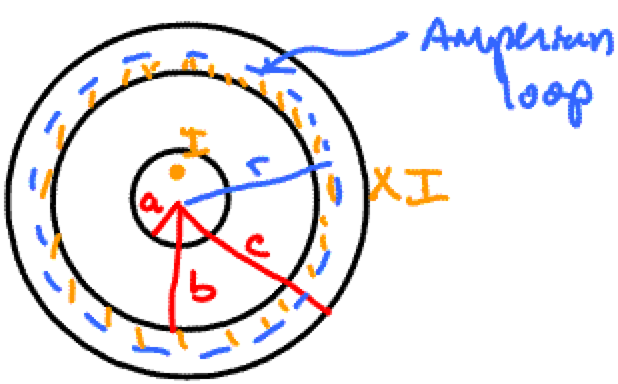
$b < r < c$

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

$$|\vec{B}|\, 2\pi r = \mu_0 \overbrace{\underbrace{I_{encl}}}^{\text{harder}}$$

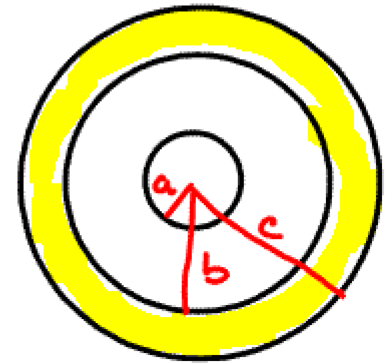
Inner contrib $= I$

outer contrib $\to$ calc



Problem says const j in outer conductor

$$|j_{outer}| = \frac{I}{\pi c^2 - \pi b^2}$$



$$I_{encl} = I_{(inner)} - \int j_{outer}\, dA$$

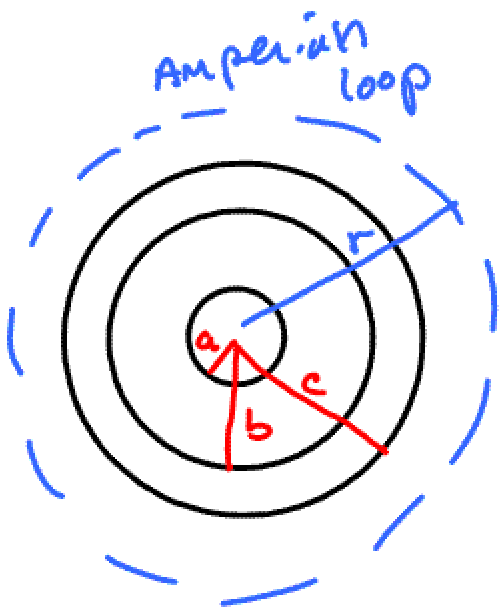
$$I_{encl} = I_{(inner)} - j_{outer} (\pi r^2 - \pi b^2)$$

$$I_{encl} = I - I \left[\frac{\pi r^2 - \pi b^2}{\pi c^2 - \pi b^2} \right]$$

Ampere's law

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

$$|\vec{B}|_{c>r>a} = \frac{\mu_0 I}{2\pi r}\left\{1 - \left[\frac{\pi r^2 - \pi b^2}{\pi c^2 - \pi b^2}\right]\right\}$$



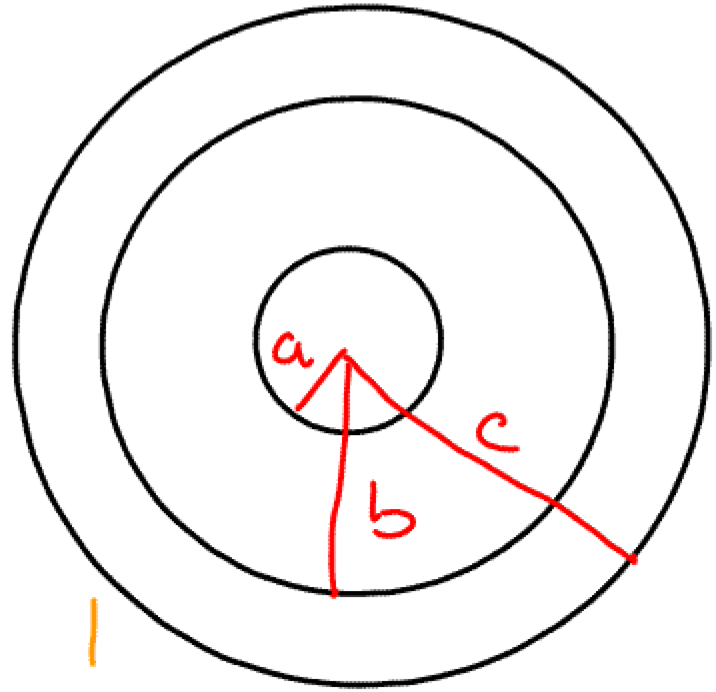
$r > c$

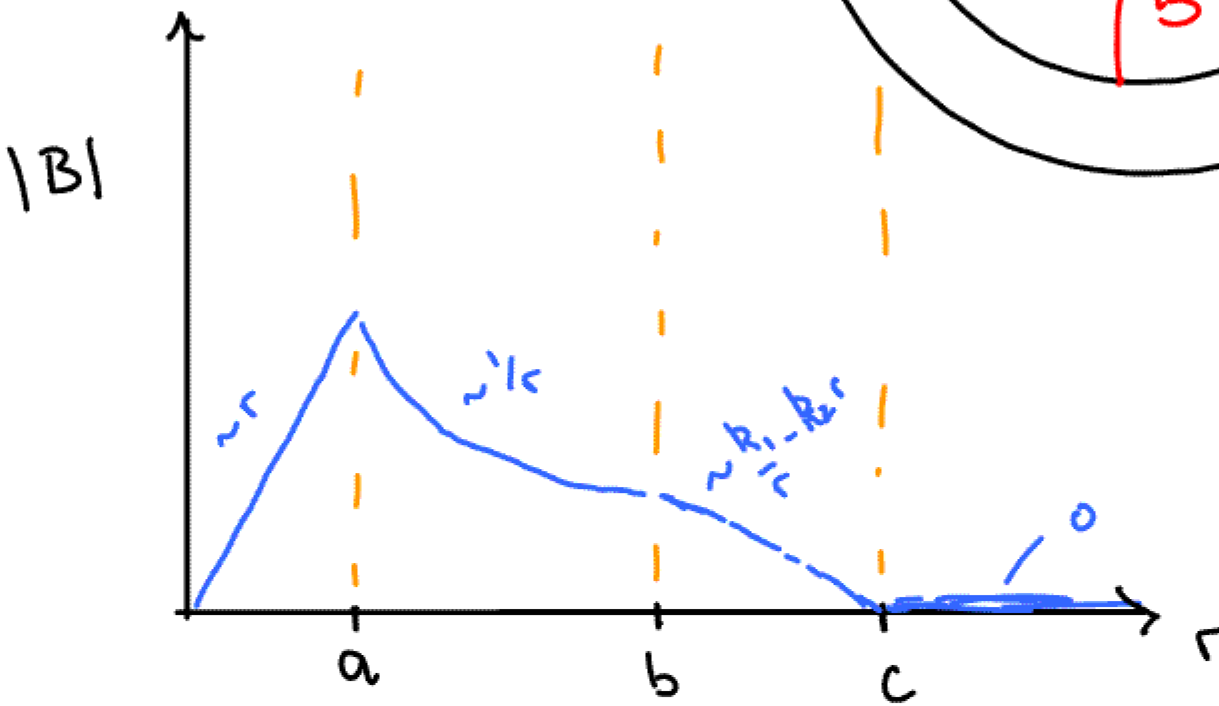
$$\int \vec{B}\cdot d\vec{s} = \mu_0 I_{enc}$$

$$|\vec{B}|\,2\pi r = \mu_0\,0$$

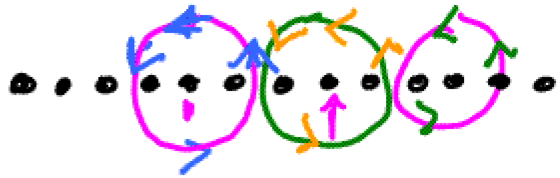
$$|\vec{B}|_{r>c} = 0$$

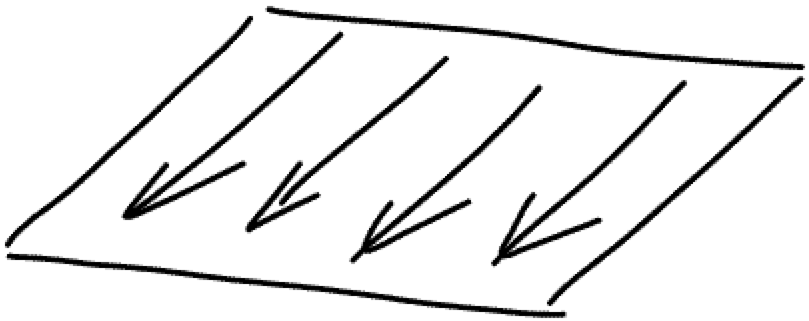
coaxial conductor example





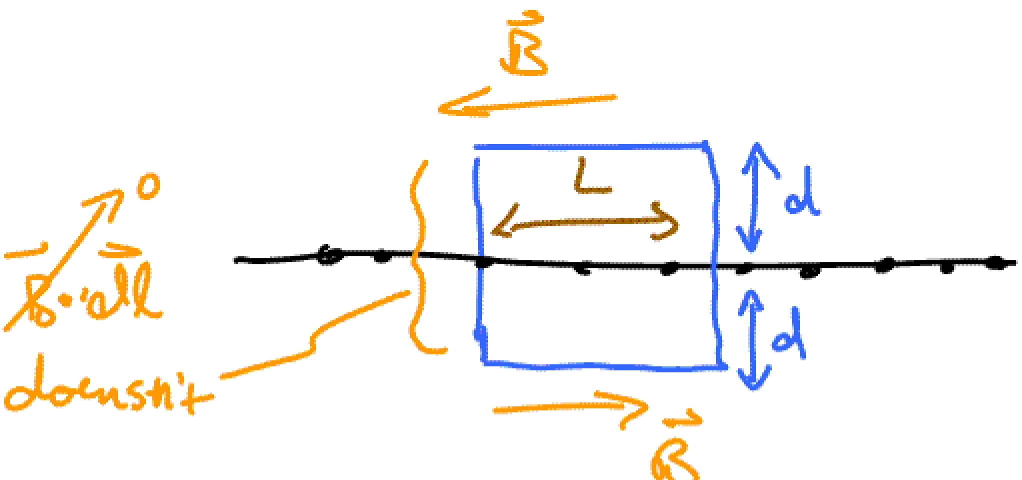
End of Material for Exam 2





∞ current sheet

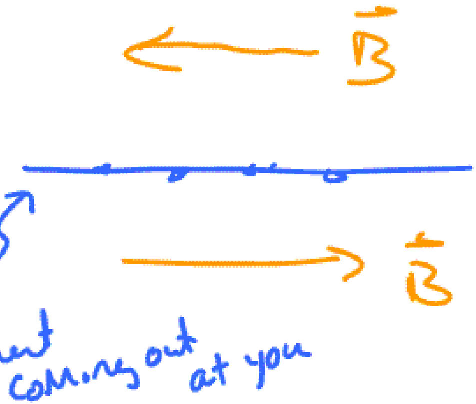
current density j



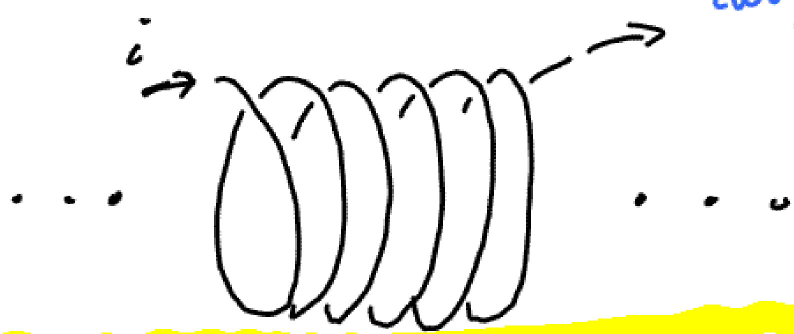
$I_{\text{within } L} = jL$

$$\oint \vec{B}\cdot d\vec{l} = 2|B|L = jL\mu_0$$

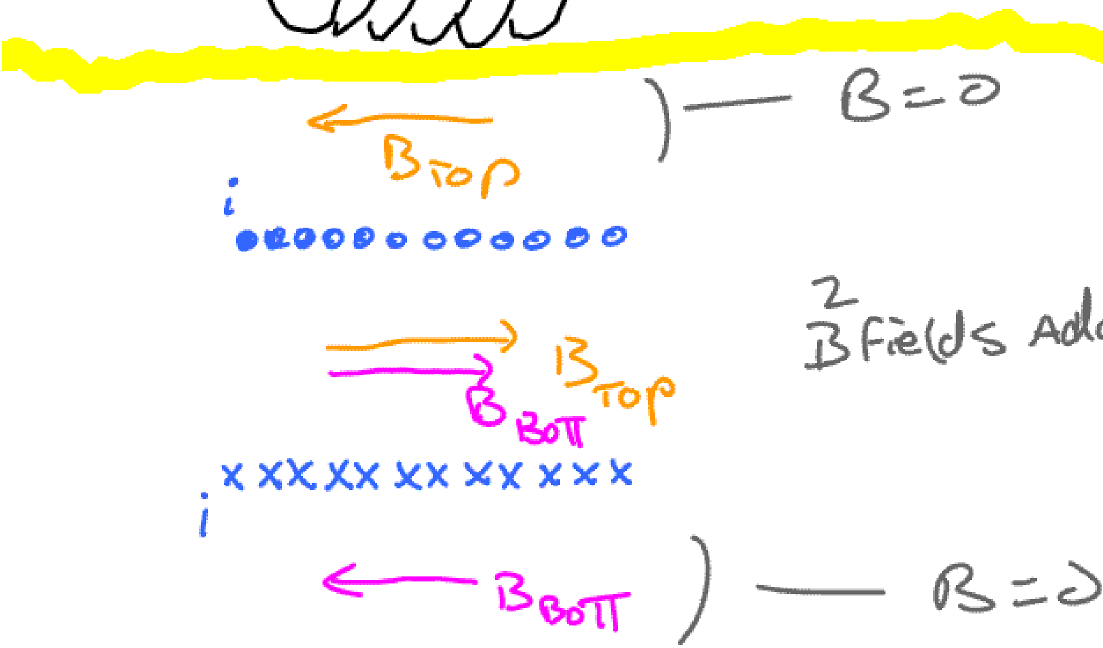
$$|\vec{B}| = \frac{j\mu_0}{2}$$



∞ Solenoid



Picture a long, rigid Slinky

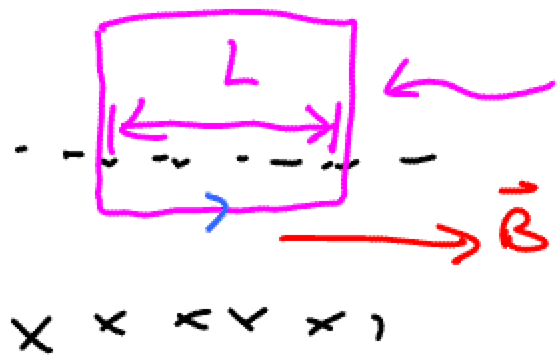


2 B Fields Add

cut slinky Down Middle + look at from side

Solenoid $\quad n$ turns/length

$I_{encl} = Lin$



$$\oint \vec{B} \cdot d\vec{l} = |B| L = \mu_0 I_{enc}$$

$$|B| L = \mu_0 L i n$$

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

CONSTANT B field inside Solenoid
outside $B = 0$