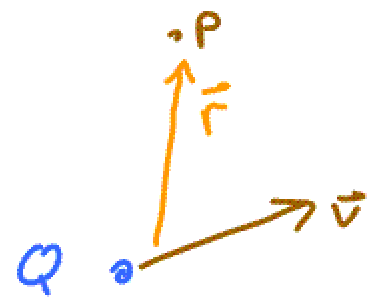
Physics 142 - October 20, 2005

Amperes Law, Right hand rules, Induction

Last time:



Biot-Savart

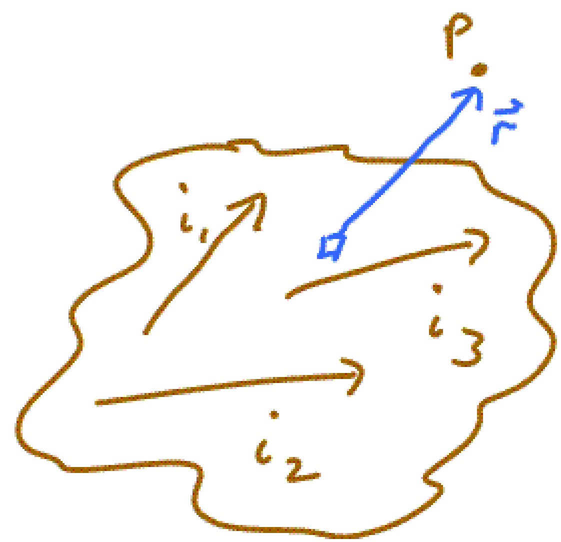
$$\vec{B} = \frac{\mu_0}{4\pi} \frac{Q\vec{v}\times\hat{r}}{r^2}$$

single charge moving

Important

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

distribution of currents



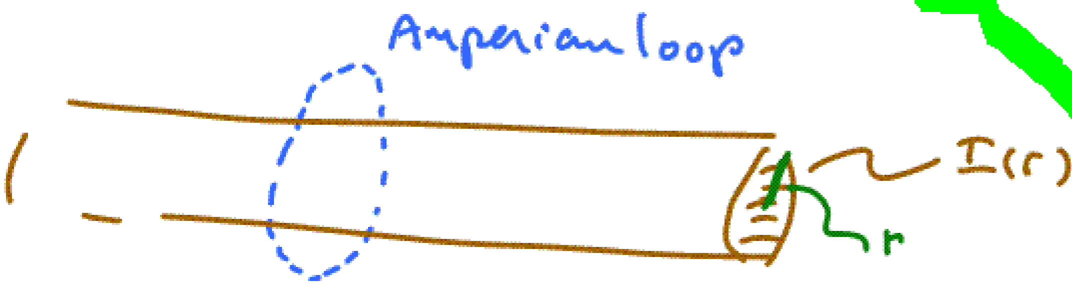
Ampere's Law:

Important

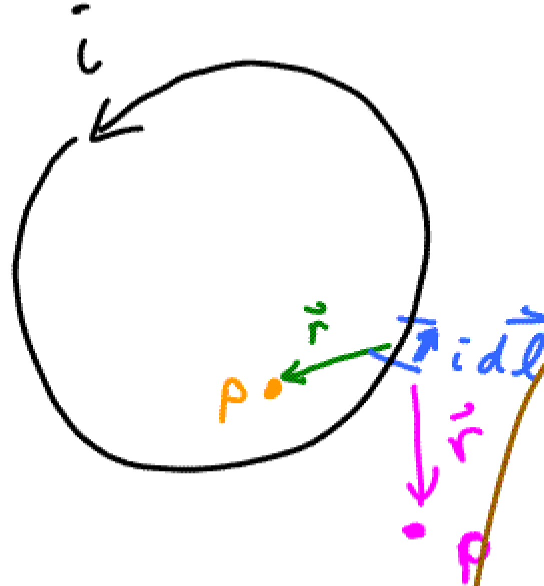
$$\int_{\substack{\text{closed}\\\text{loop}}} \vec{B}\cdot d\vec{\ell} = \mu_0 I_{enclosed}$$

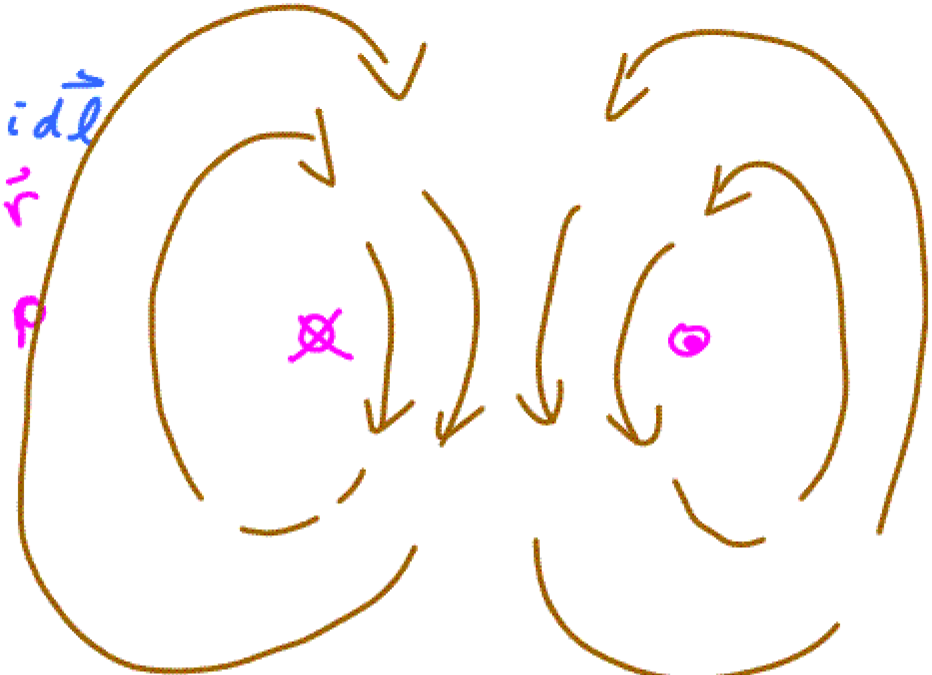
sometimes see $\oint \vec{B}\cdot d\vec{\ell} = \mu_0 I_{encl}$

choose loop so
$\vec{B}\cdot d\vec{\ell}$ simple
$|\vec{B}| = \text{constant}$

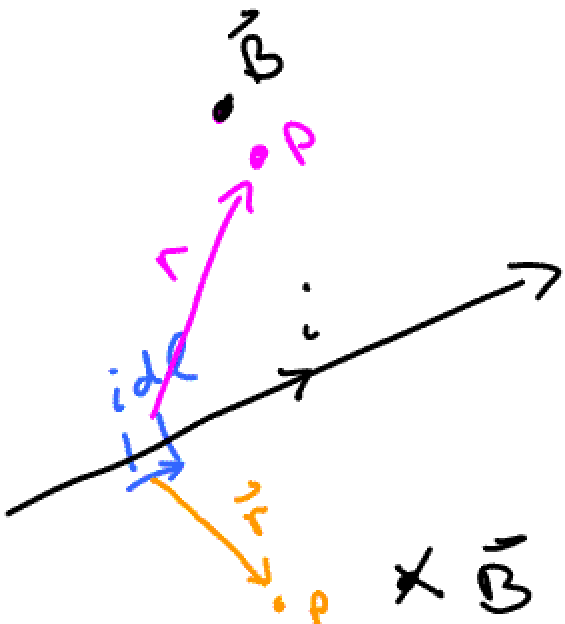


$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{i\, d\vec{l} \times \hat{r}}{r^2}$$

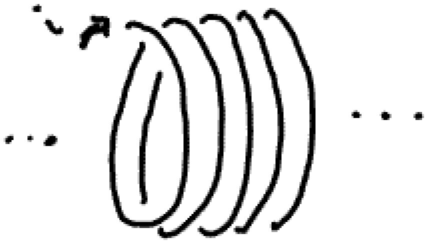




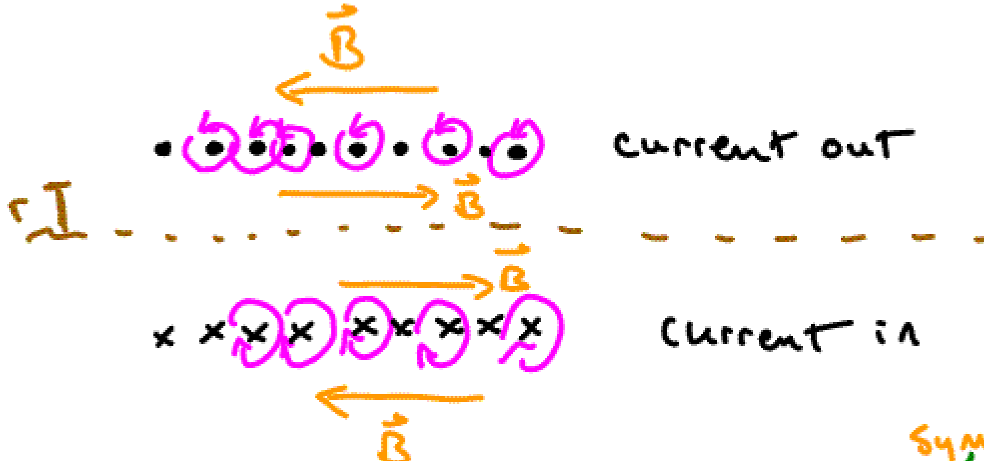
magnetic dipole



Field of an infinite Solenoid



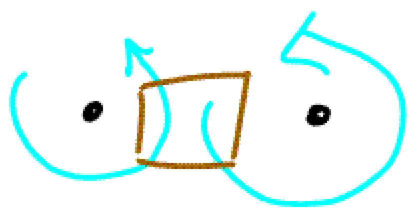
n loops/unit length

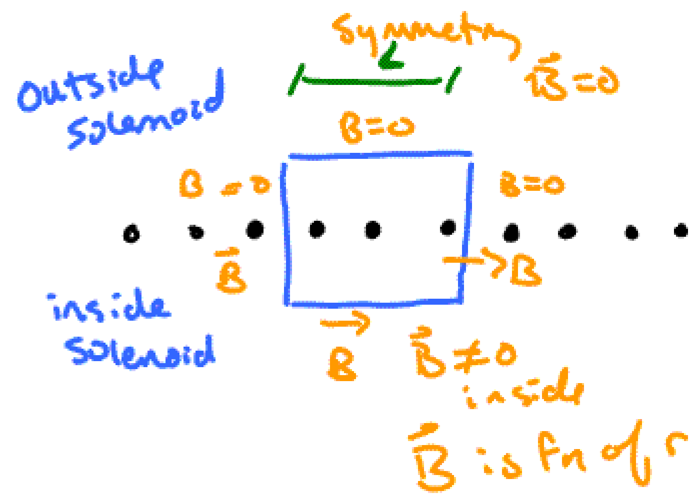


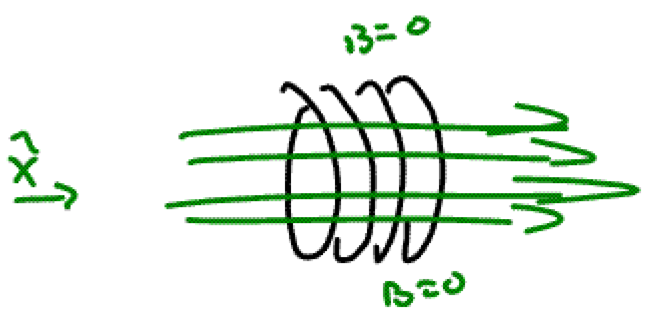
$$\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{encl}$$

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

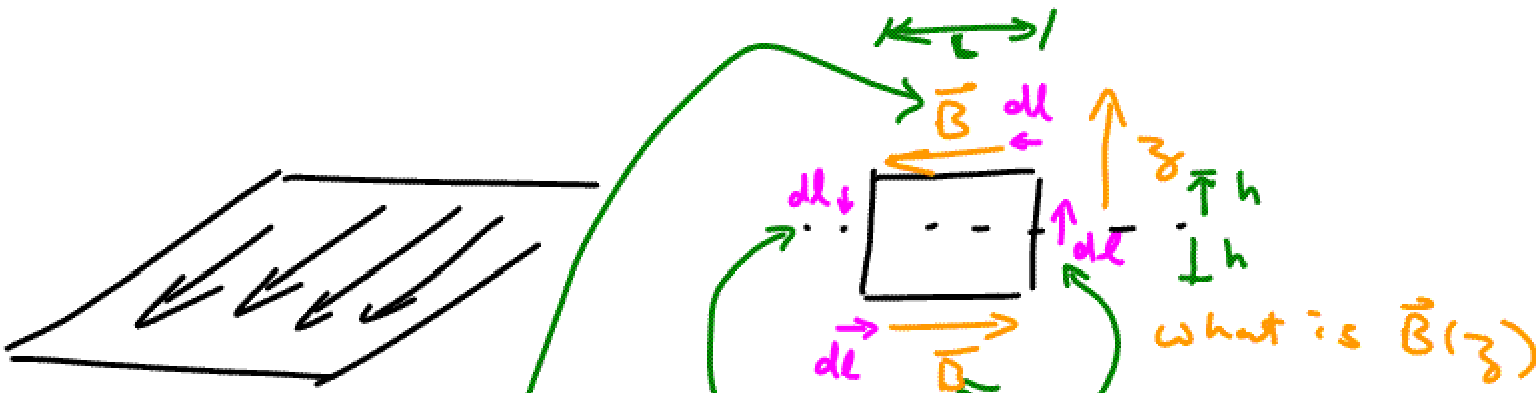
$$|\vec{B}| = \mu_0 i n$$







$$\vec{B} = \mu_0 i n\,\hat{x}$$



$\vec{B}\cdot d\vec{l} = 0$

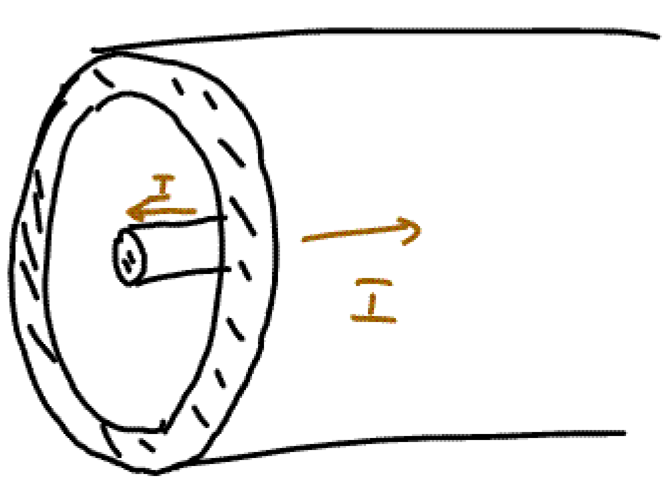
$\vec{B}\cdot d\vec{l} = B\,dl$

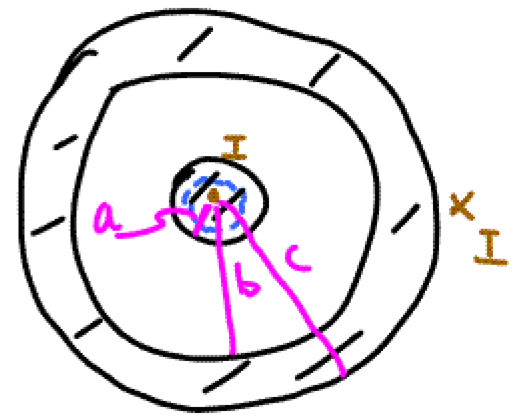
$$\underbrace{\oint \vec{B}\cdot d\vec{l}}_{2|\vec{B}|L} = \mu_0 I_{enc}$$

$$2|\vec{B}|L = \mu_0 \lambda L \rightsquigarrow |\vec{B}| = \frac{\mu_0\lambda}{2}$$

current density

Long coaxial cable





Assume I uniform across both conductors

Find $\vec{B}$ in all space —

$r<a$

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

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

current density

$$I/\pi a^2 = j$$

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

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