Physics 142 - October 18, 2005

Magnetism, Biot-Savart, Ampere's law

- PAS email server issues

  got 1 email (Zach Kozick) from P142 student since Friday – if you sent email that I did NOT receive – Try again or call/speak to me

- Exam 2: Nov. 15 0800-0920 B+L 109

  NOT 0830 as STATED in Syllabus

- Project Groups

Railgun: Bennett, Webster, Kozick, Stacey

Tentative railgun: Bublitz, Learnert, Stampe, Voronov

LLE: Schmitt, Pierce, Turkett, Goodridge, Faber

13 of 44 ??

Please form project groups and pick topics.

E-mail me if you need help finding a group

Last time –

Lorentz Force law

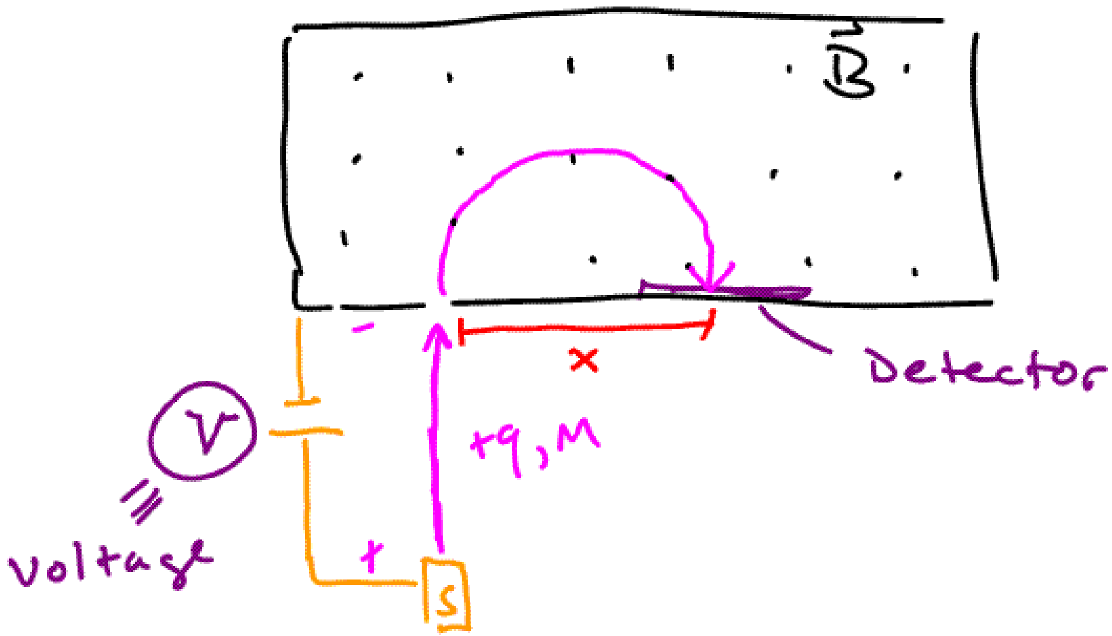
$$\boxed{\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}}$$

Important

Form of force law for $\vec{B}$ useful for currents in wires

$$\vec{F} = i\vec{L} \times \vec{B} \quad \text{or} \quad \ell \vec{I} \times \vec{B}$$

Mass Spectrometer



V = velocity

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

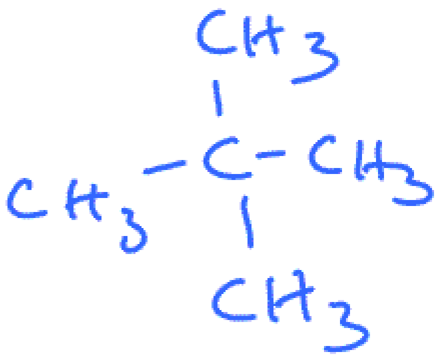
$$qvB = \frac{mv^2}{R} \qquad m = \frac{qRB}{v}$$

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

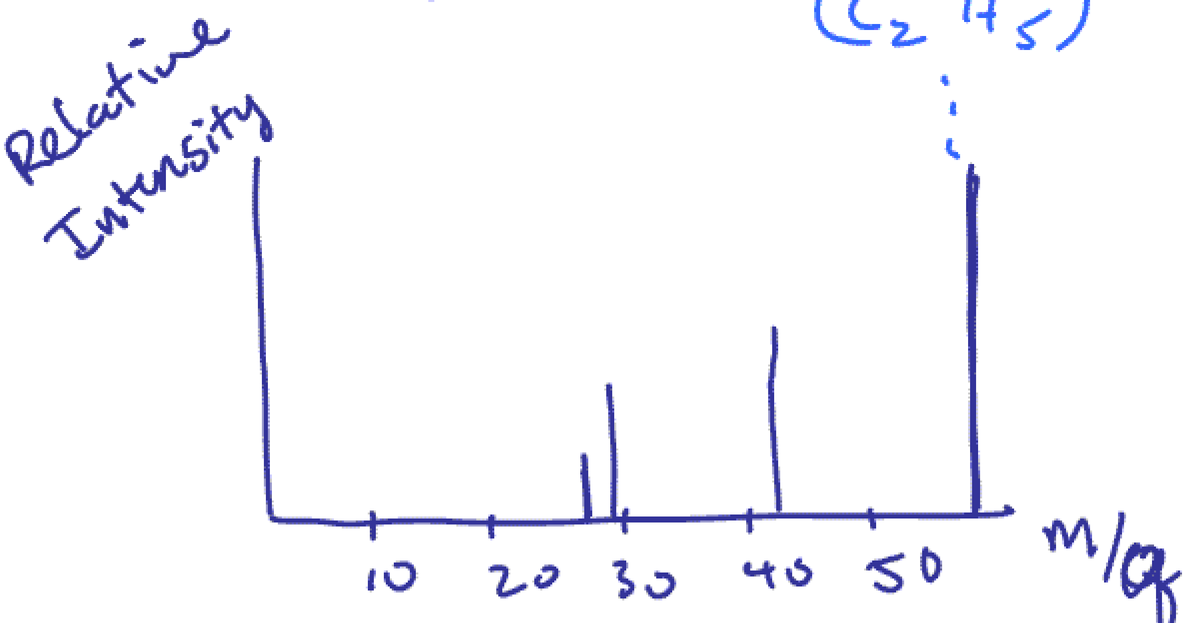
$$v = \left(\frac{2qV}{m}\right)^{1/2}$$

$x = 2R$

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



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

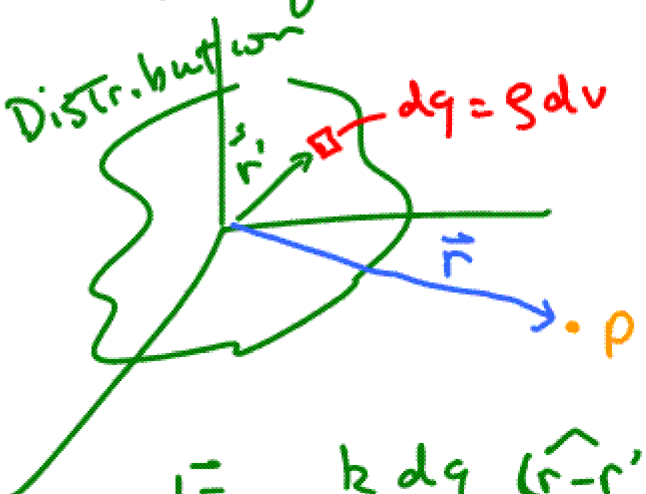


Electrostatics

Coulomb's Law

$$\vec{E} = \frac{kQ\,\hat{r}}{r^2}$$

$$\vec{F} = q\,\vec{E}$$



$$d\vec{E}_p = \frac{k\,dq}{(r-r')^2}\,\widehat{(r-r')}$$

Magnetostatics

Law of Biot-Savart

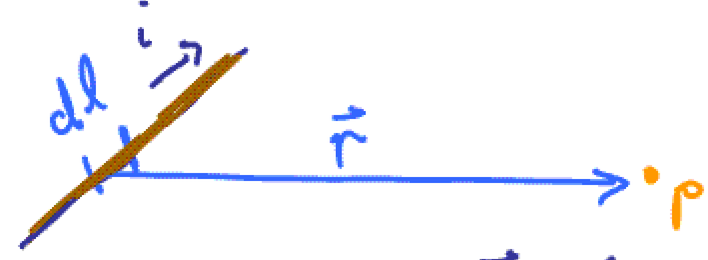
$$\vec{B}_{\substack{at\ p\\ due\ to\ Q}} = \frac{\mu_0}{4\pi}\,\frac{Q\,\vec{v}\times\hat{r}}{r^2}$$

$\mu_0 \equiv$ const. $\equiv$ Permeability of free space

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

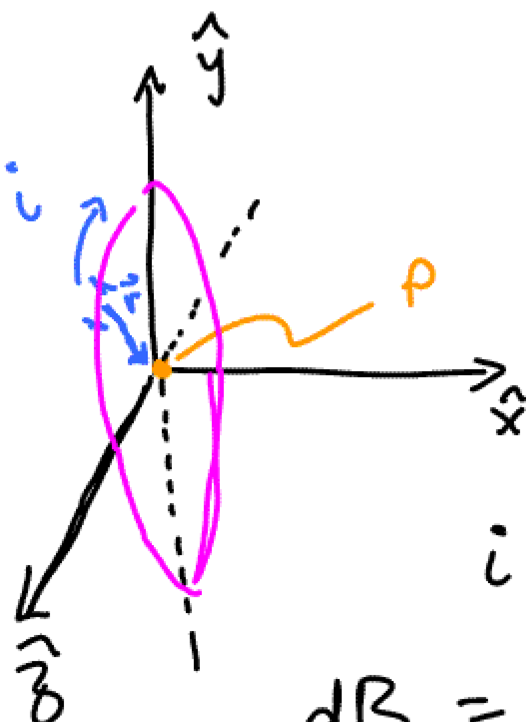
Distribution

currents (not charges)



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

due to dl of current

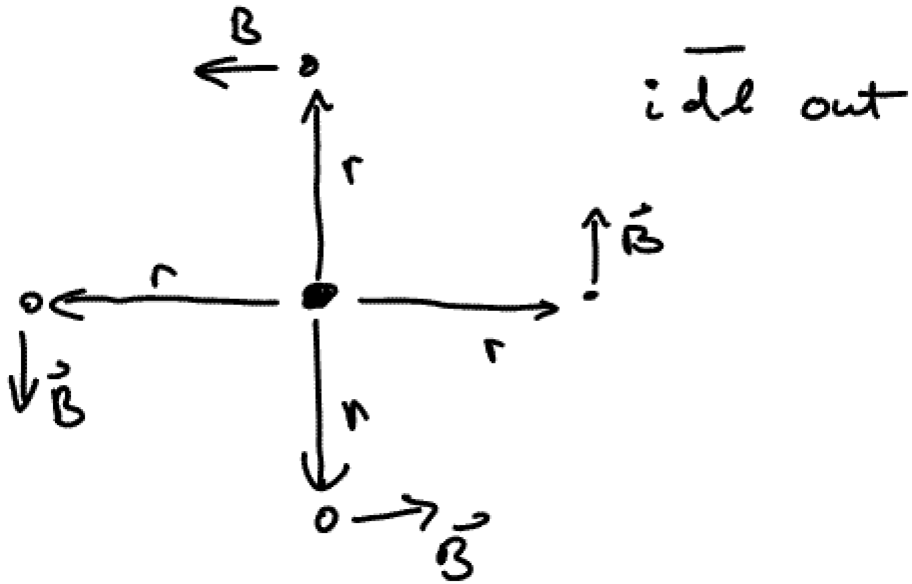


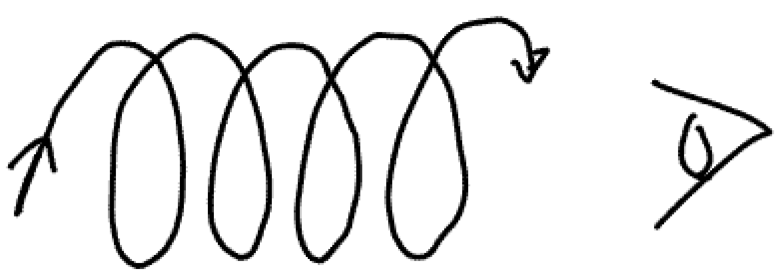
Find $\vec{B}$ at origin

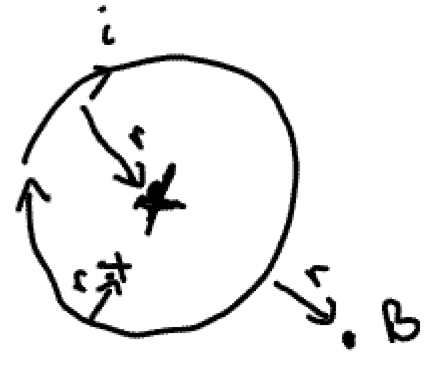
$$i\,d\vec{l}\times\hat{r} = i\,dl(-\hat{x})$$

$$dB = \frac{\mu_0}{4\pi}\frac{i\,dl}{r^2}(-\hat{x}) \qquad dl \simeq ds$$

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


$i\,\overline{dl}$ out
B
r
r
r
r
$\vec{B}$
$\vec{B}$
$\vec{B}$




i
r
r
r
B

Electrostatics

Gauss' Law

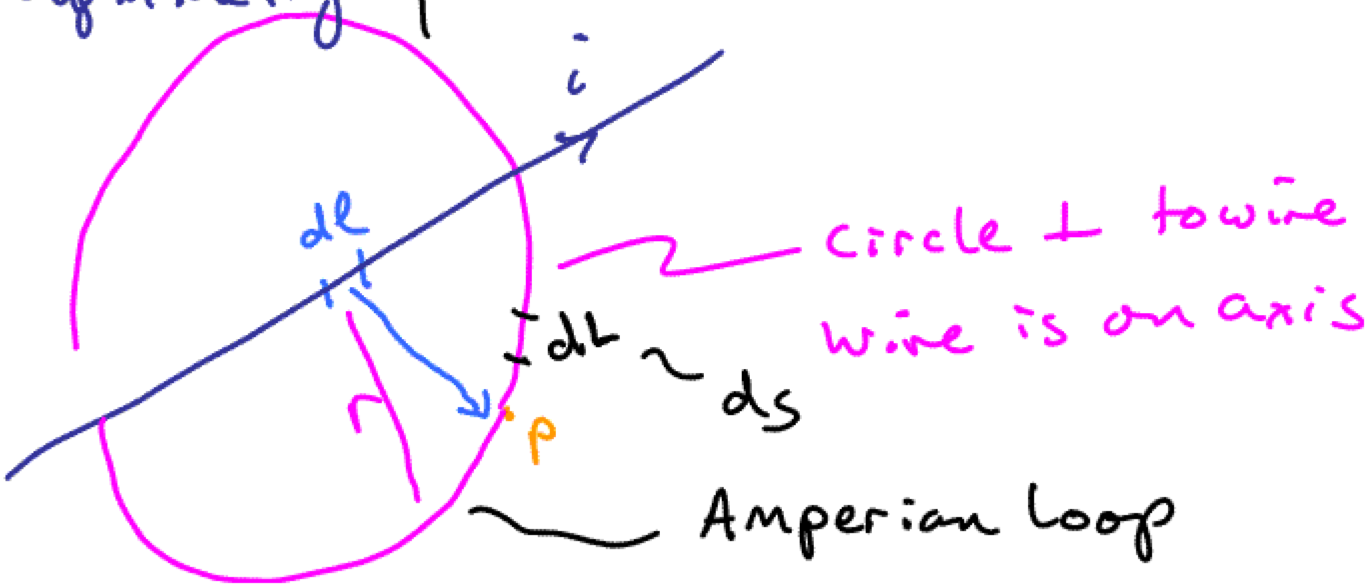
$$\int_{\text{surf.}} \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

good for situations w/ particular symmetry

Magnetostatics

Ampere's Law

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



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

$$|\vec{B}| \int_0^{2\pi r} ds = |\vec{B}| 2\pi r = \mu_0 i$$

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