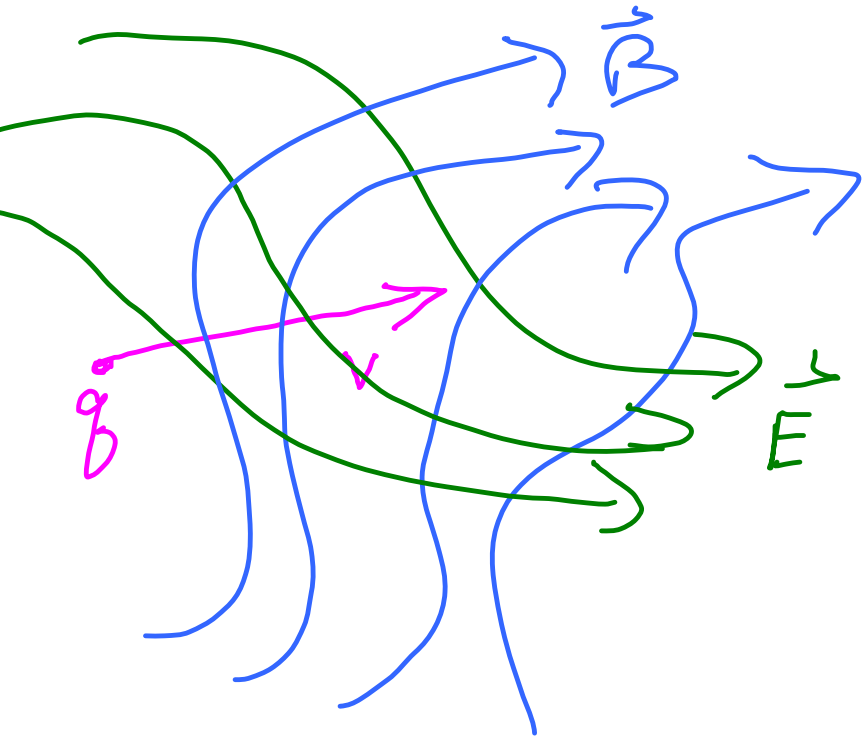
Physics 142 - October 28, 2014

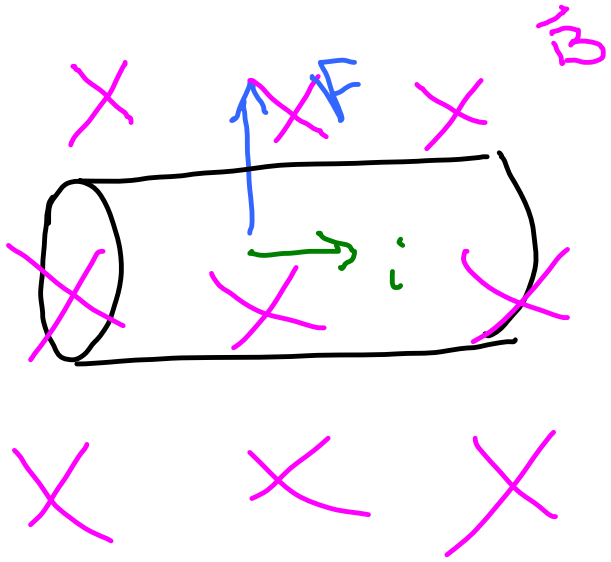
- Will post project group member listings Today (hopefully)

Last Time

Let there be magnetism!



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



$$\vec{F}_{wire} = q(\vec{V}_d \times \vec{B})\, n A L$$

cross sect

length

$\vec{V}_d$: drift velocity

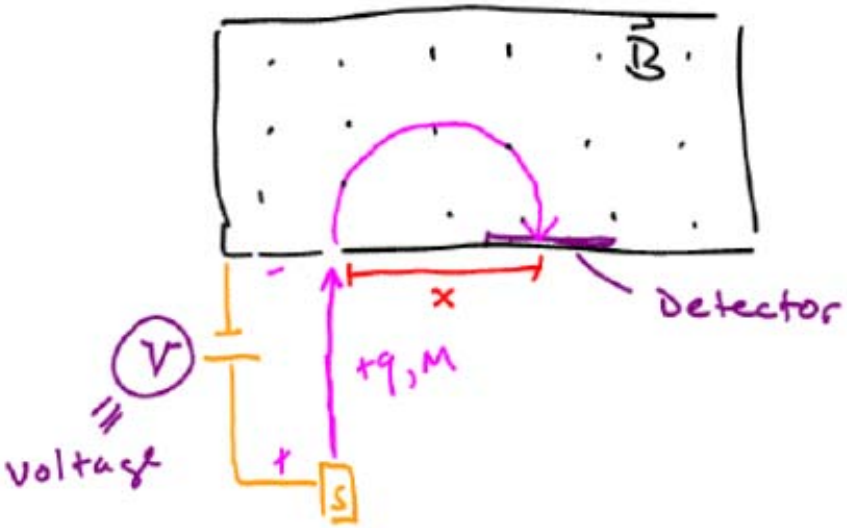
n: charge / vol

$$i = nqV_d A$$

n: # / volume

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

Mass Spectrometer



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

v = velocity

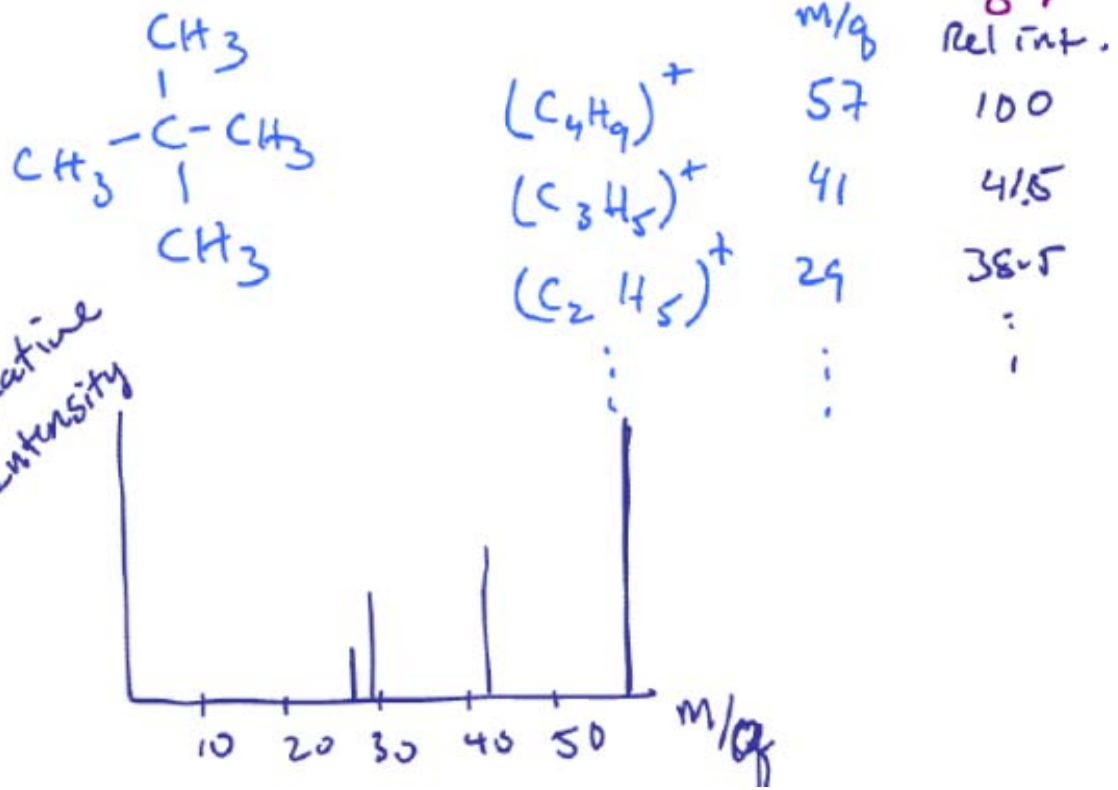
$qvB = \frac{mv^2}{R} \qquad m = \frac{qRB}{v}$

$KE = +qeV = \frac{1}{2}mv^2$

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

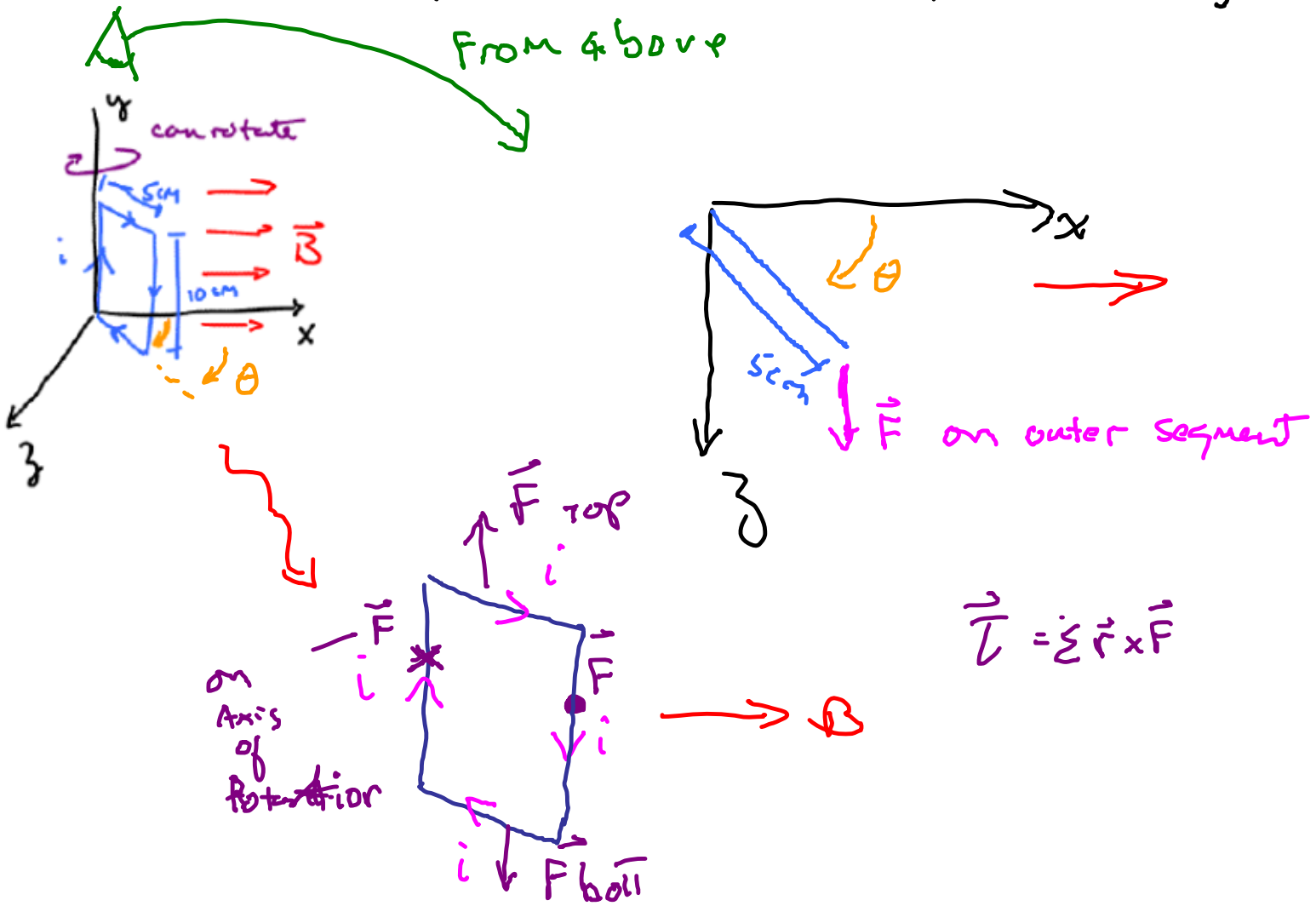
$x = 2R$

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

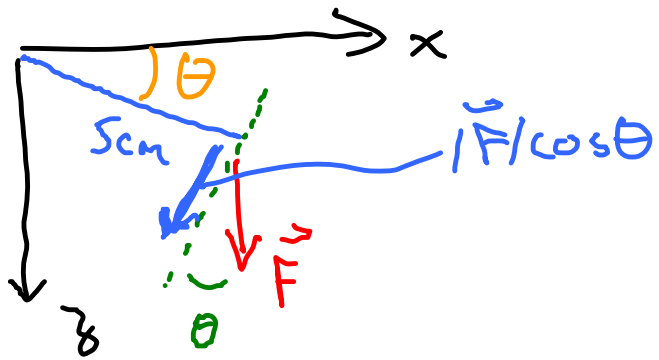


	m/q	Rel int.
$(C_4H_9)^+$	57	100
$(C_3H_5)^+$	41	41.5
$(C_2H_5)^+$	29	38.5
⋮	⋮	⋮

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



$$\vec{\tau} = \Sigma \vec{r} \times \vec{F}$$



$$\vec{\tau} = \underbrace{r\cos\theta}_{} \; \underbrace{iLB}_{F_B}$$

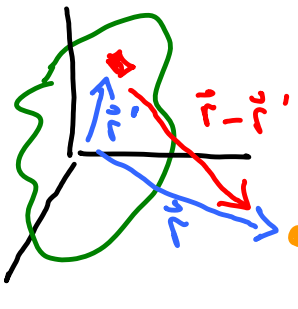
in $-\hat{y}$ direction

Electrostatics

Coulomb's Law

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

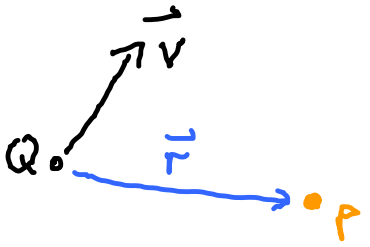
$$\vec{F} = q\vec{E}$$



$$d\vec{E}_P = \frac{k\,dq}{|r-r'|^2}(\hat{r}-\hat{r}')$$

Magnetostatics

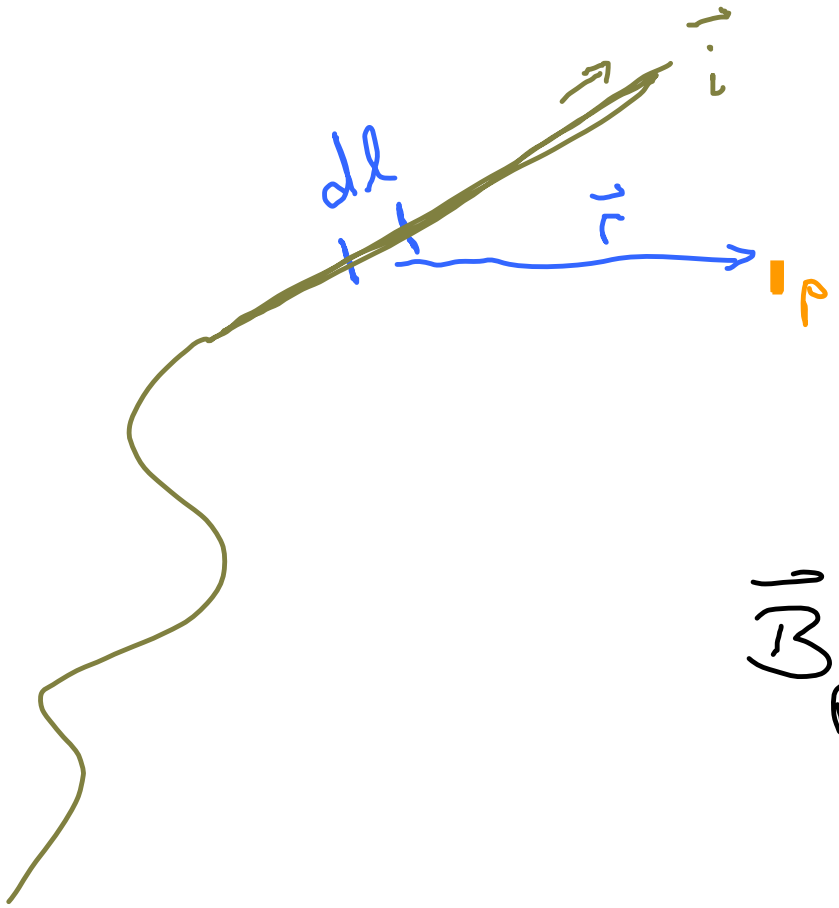
Law of Biot-Savart



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

μ_0 = CONSTANT = Permeability of free space

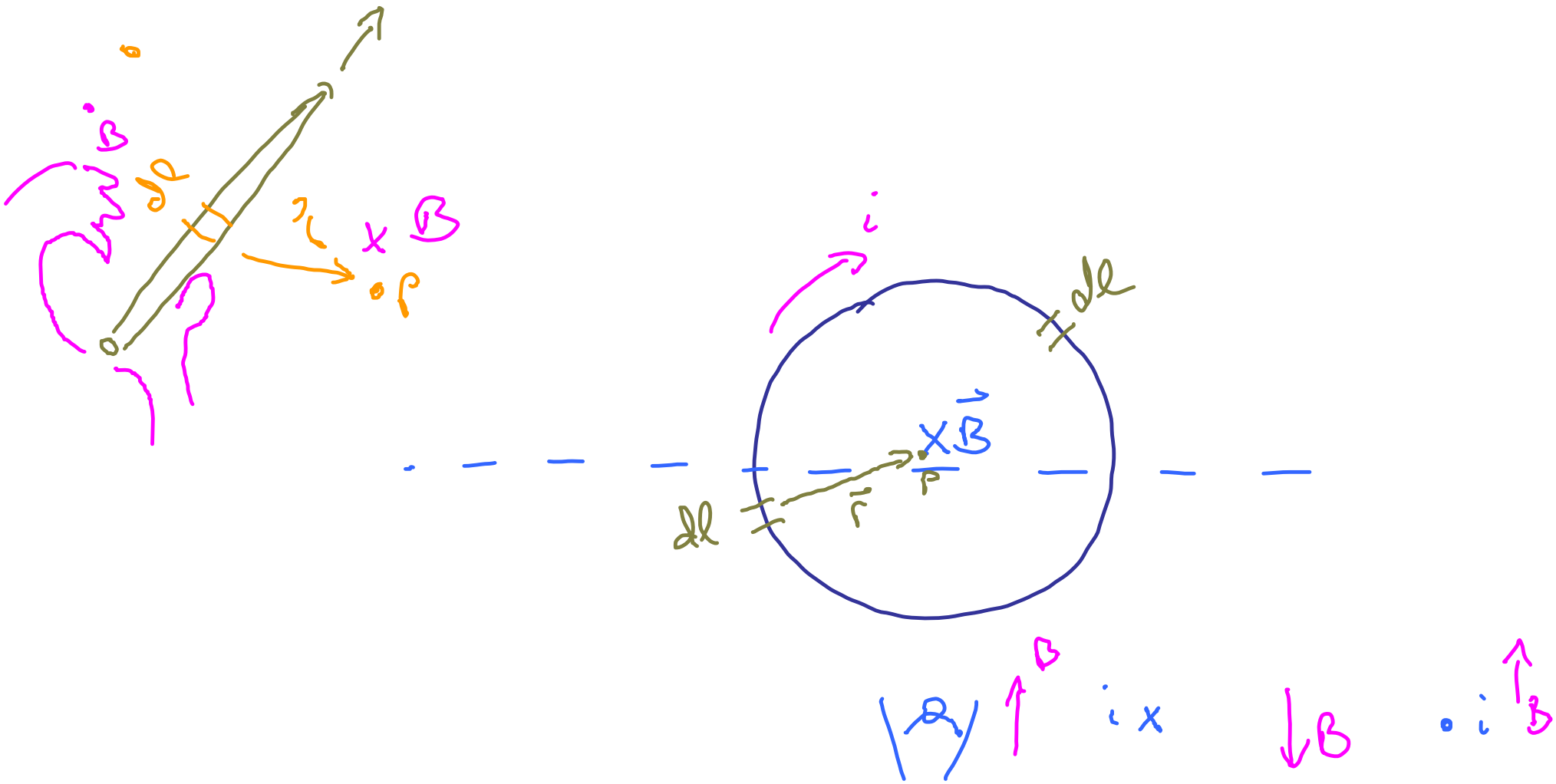
$$= 4\pi \times 10^{-7}\ \frac{T\cdot M}{A}$$

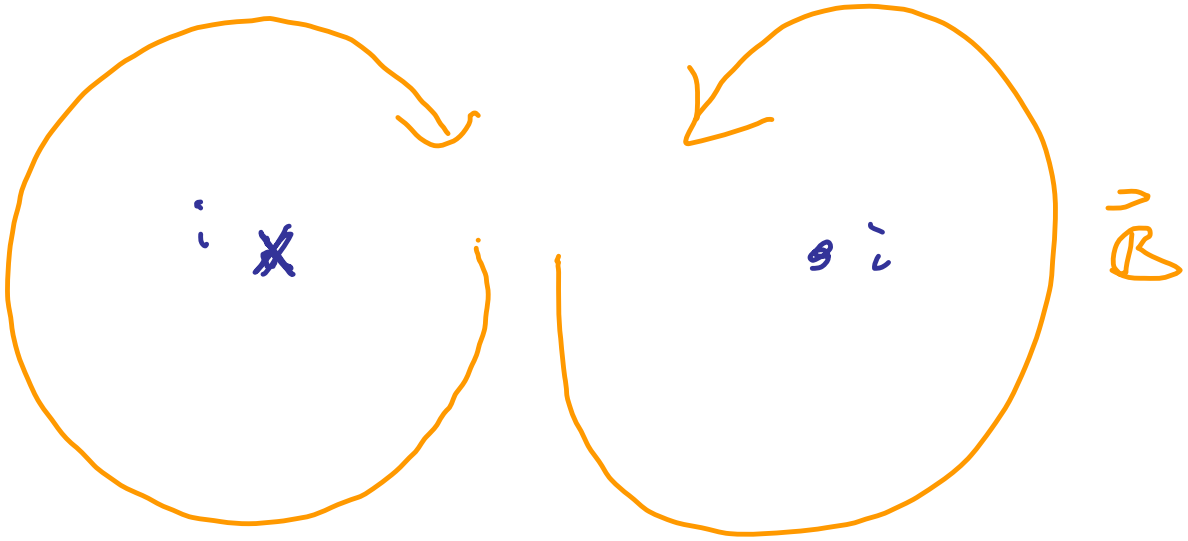


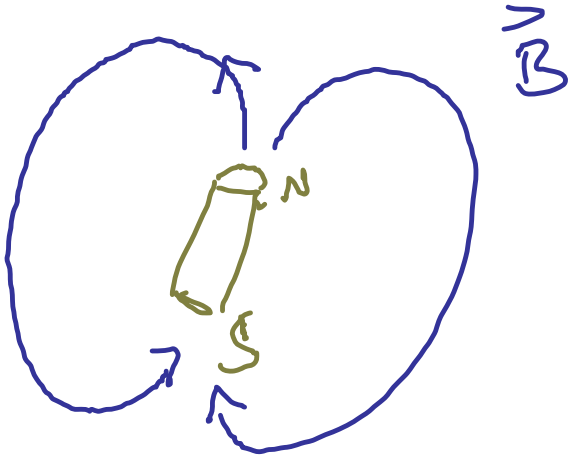
$$d\vec{B}_P = \frac{\mu_0}{4\pi} \frac{i\vec{dl} \times \hat{r}}{r^2}$$

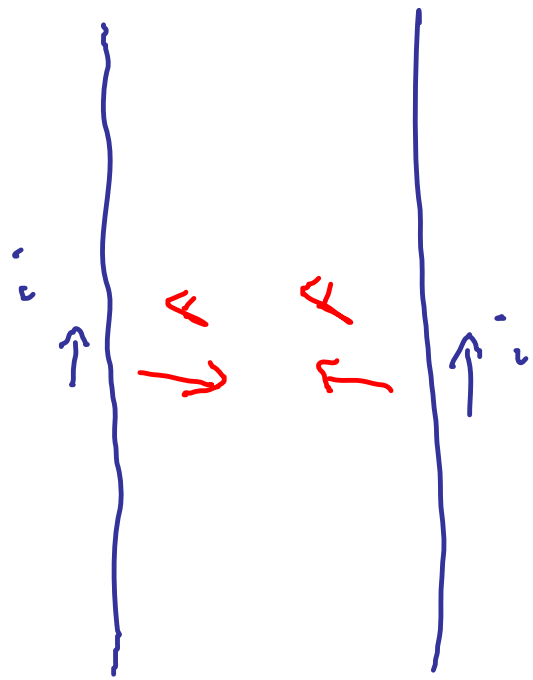
due to differential length dl of current i:

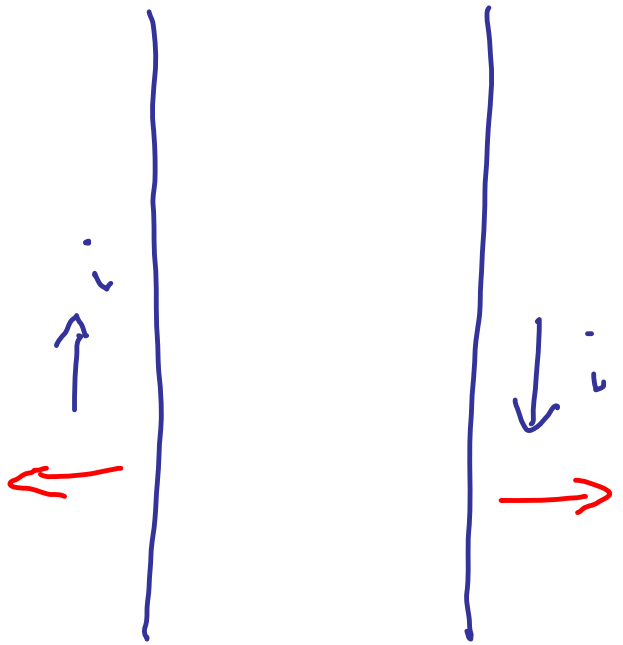
$$\vec{B}_P = \frac{\mu_0}{4\pi} \int_{\text{current dist.}} \frac{i\vec{dl} \times \hat{r}}{r^2}$$

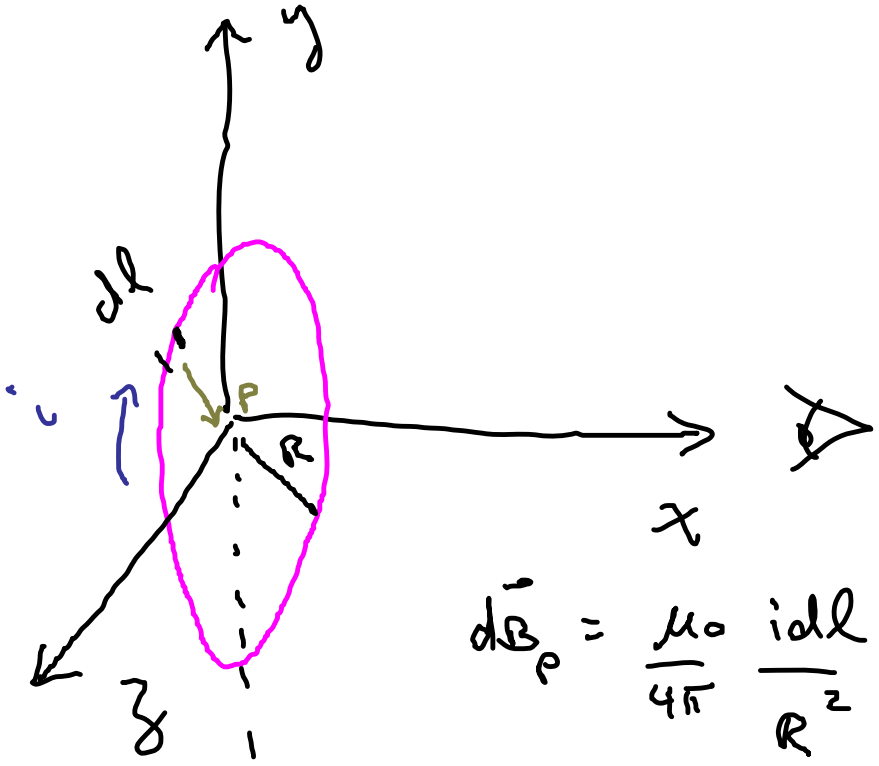

B
dl
r
x B
P
i
dl
x B
dl
r
P
B
i x
B
i
B


i
i
$\vec{B}$


$\vec{B}$
N
S







Find $\vec{B}$ at origin

circle has radius R

RHR $\vec{B}$ in $-\hat{x}$

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

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

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

$$\vec{B} = \frac{\mu_0 i}{2R}(-\hat{x})$$