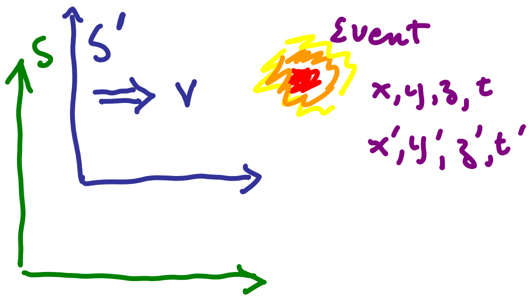
Physics 142 - October 23, 2014

- Have sorted class into project groups
- Most of you got your topic preference or something close
- Will notify you of groups shortly
- You meet, think, plan a bit ... then set up Appt w/ me
- Think of the end product ...

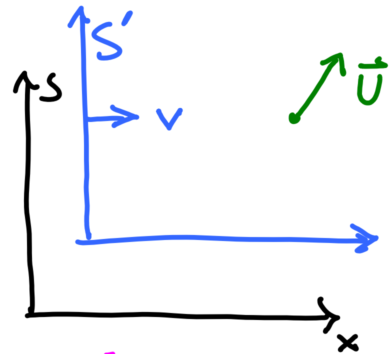


Lorentz Transformations

$$\left\{\begin{aligned} x' &= \gamma(x - vt) \\ y' &= y \\ z' &= z \\ t' &= \gamma\left(t - \frac{vx}{c^2}\right) \end{aligned}\right\}$$

$V \rightarrow$ small $\Rightarrow \gamma = 1$ $\quad \frac{v}{c} \rightarrow 0$ get Gallilean Transformations

Velocity Transformations



$$u_x' = \frac{u_x - v}{1 - \frac{v}{c^2} u_x}$$

Along direction of relative motion between reference frames

$$u_y' = \frac{u_y}{\gamma\left(1 - u_x \frac{v}{c^2}\right)}$$

$$u_z' = \frac{u_z}{\gamma\left(1 - u_x \frac{v}{c^2}\right)}$$

Components transverse to direction of relative motion between reference frames define $\eta = \dfrac{dx}{d\tau}$]— space]— proper time   proper velocity

and relativistic momentum $p = m\eta$

Momentum conservation holds $\sum p_i = \sum p_f$

if define "4^{th} component of momentum"

to be $\underbrace{\gamma m c^2}_{\text{relativistic energy}} = E$

Spacetime TRANSformation

$x' = \gamma(x - vt)$

$y' = y$

$z' = z$

$t' = \gamma\left(t - \dfrac{vx}{c^2}\right)$

Energy Momentum TRANSformation

$p_x' = \gamma(p_x - v\gamma m c^2)$

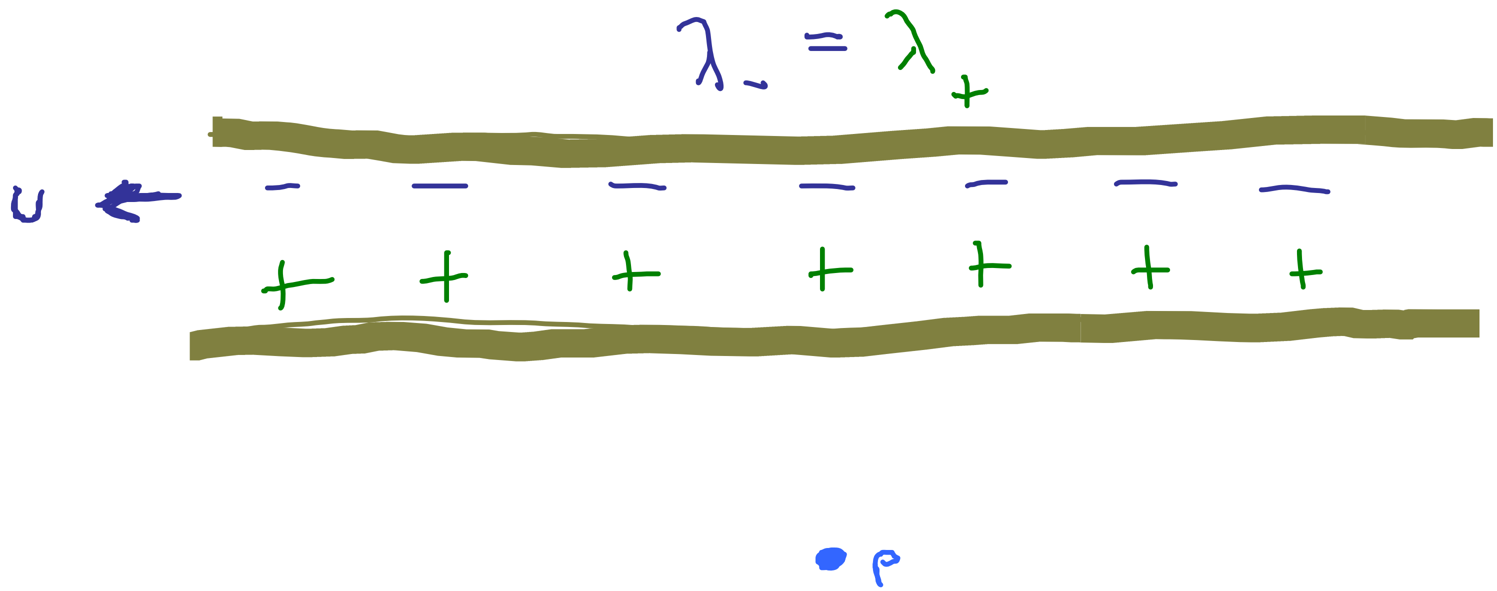
$p_y' = p_y$

$p_z' = p_z$

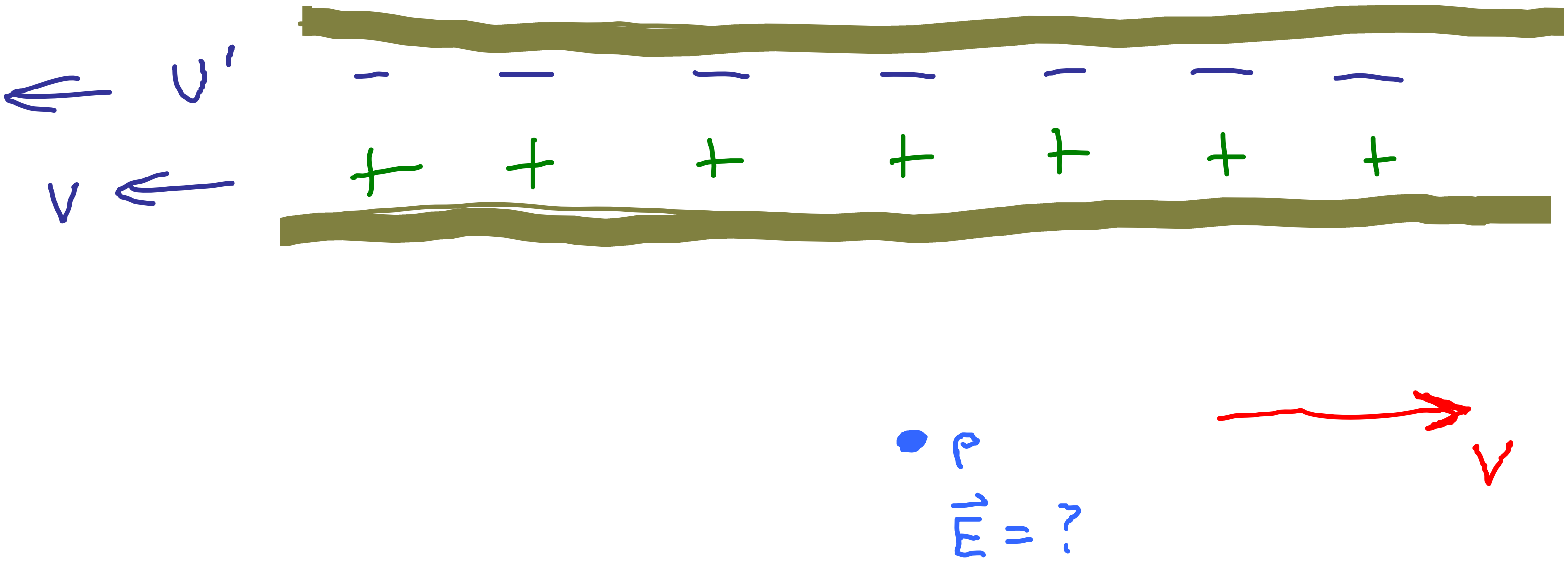
$E' = \gamma\left(E - \dfrac{v p_x}{c^2}\right)$

$(\vec{x}, t)$ 4 vectors

$(\vec{p}, E)$



$\vec{E} = ?$



v'
v
p
$\vec{E} = ?$
v

Magnetism

Magnetic field

$\equiv \vec{B}$

MKS unit Tesla

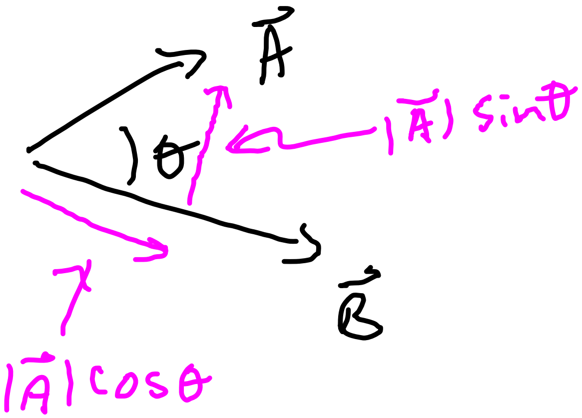
cgs unit gauss

Lorentz Force law

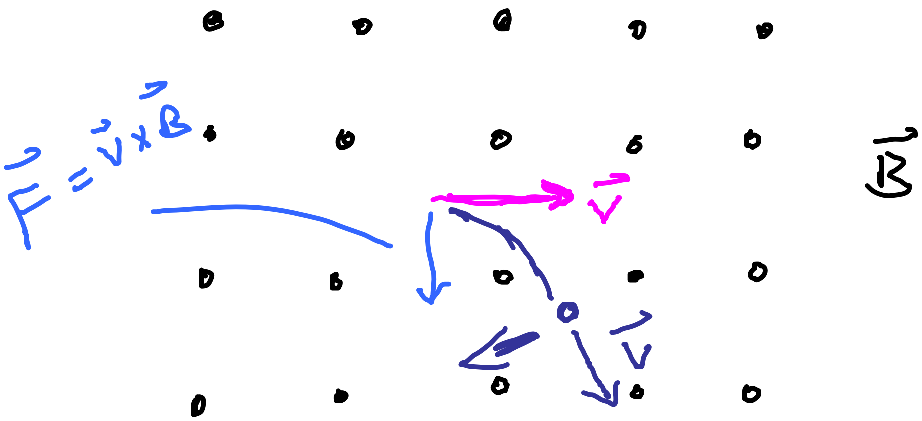
$$\boxed{\vec{F} = q\vec{E} + q\,\underbrace{\vec{V} \times \vec{B}}_{\text{cross product}}}$$

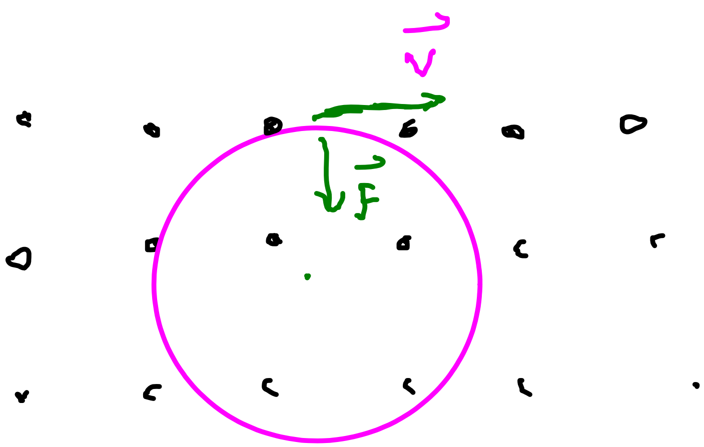
$\vec{A} \times \vec{B} \longrightarrow$ vector

$$|\vec{A} \times \vec{B}| = |\vec{A}|\,|\vec{B}| \sin\theta$$



$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} = \hat{i}\left(A_y B_z - A_z B_y\right) - \hat{j}\left(A_x B_z - A_z B_x\right) + \hat{k}\left(A_x B_y - A_y B_x\right)$$



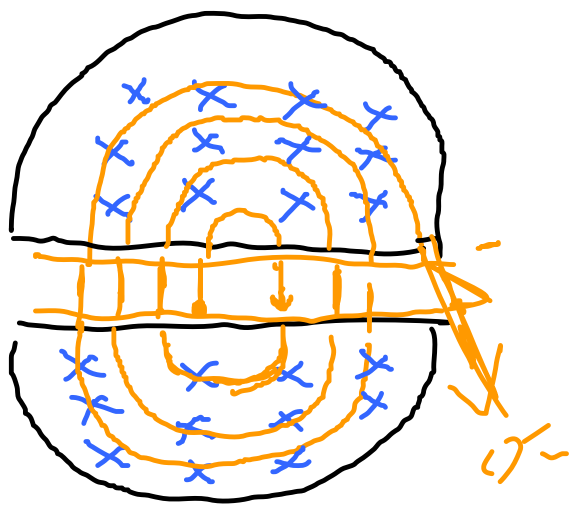


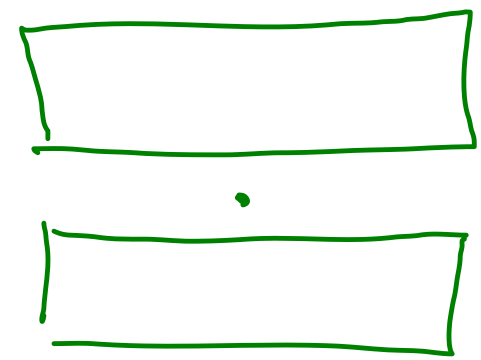
Uniform $\vec{B}$

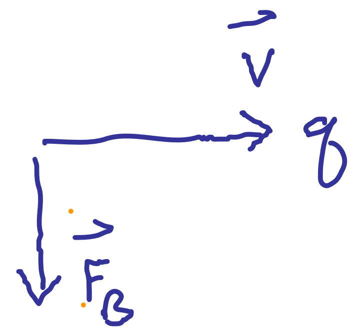
$$F_c = \frac{mv^2}{R} = qvB$$

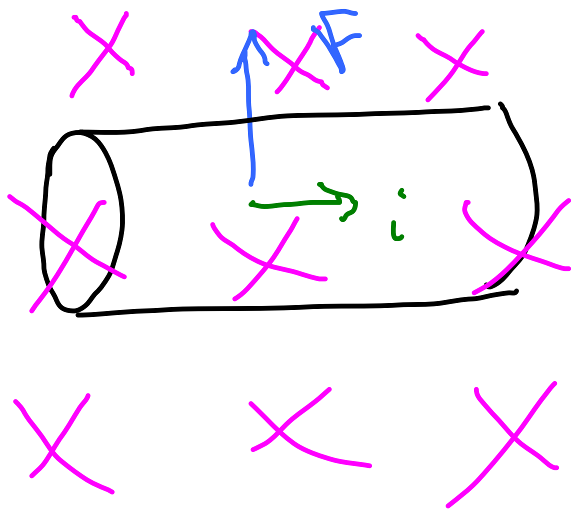
$$R = \frac{mv}{qB}$$

Cyclotron









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

cross sect

length

drift velocity

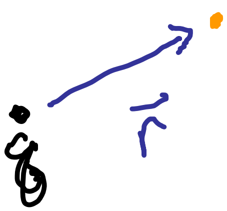
charge / Vol

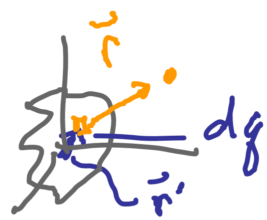
$$i = n q V_d A$$

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

Electrostatics

Coulomb's law





$$dE_p = \frac{k\,dq}{|r-r'|^2}\,\widehat{(\vec{r}-\vec{r}')}$$

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

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

Magnetostatics

Arrgh...

out of time