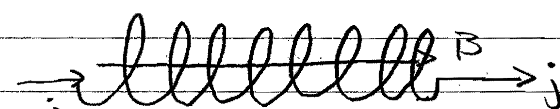
2/16/10

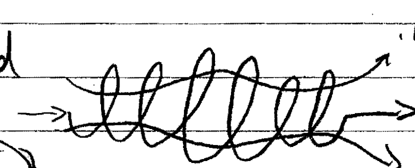
- Continue reading: Rest of Chapter 4 (Confinement), Chapter 5 (Trajectories)
- Check out equivalent pages on class website
  - Z pinch (Mag. Conf)
  - MHD equations
  - Trajectories

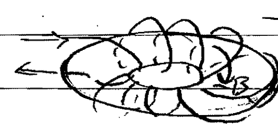
Review Session February 24, 2010; 5.00 pm
Exam March 2
HW Review / Lab Tour February 23

<u>Confinement</u>

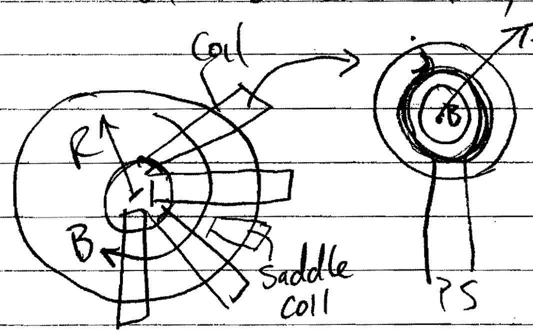
↳ Magnetic Confinement
- Confinement in two directions
- Important to close the ends of B-field
  - Bottle – Imperfect, "leaks"
  - Toroidal – Closed ends







$2\pi RB = \text{constant}$, $B \propto \frac{1}{R}$ → needs structural reinforcement



R = major radius

$$\nabla \times B = \frac{4\pi}{c} j$$

⇓ line integral

$$\int (\nabla \times B) \cdot dA = \frac{4\pi}{c} \int j \cdot dA = \text{constant}$$

$$\int (\nabla \times B) \cdot dA = \oint B \cdot dl = \text{constant}$$

Maxwell's Equations

$\nabla \cdot D = 4\pi\sigma$, σ [=] space charge

$\nabla \cdot B = 0$

$\nabla \times E = -\frac{1}{c} \cdot \frac{dB}{dt}$

$\nabla \times H = \frac{1}{c}\left(4\pi j + \frac{dD}{dt}\right)$

<u>our units</u>

$\nabla \cdot D = \rho/\epsilon_0$

$c = 1$

H = B-field density
B = B-flux density

$B = H + 4\pi M$

$\downarrow M=0$ for bound states

$B = H$

&

$D = E + 4\pi P$

$\downarrow P=0$ for plasmas

$D = E$

Maxwells

$\nabla \cdot D = \nabla \cdot E$

$\nabla \times D = \nabla \times E$

$\nabla \times B = \frac{1}{c}(4\pi j + \frac{dE}{dt}$

Our units

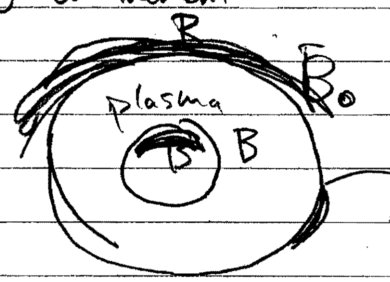
μ = permitivity = 4π

* Be able to write down Maxwells Equation's from memory

Pressure & Power Density in B-Confinement

$p_{PL} = 2nkT$

$p_B = p_{mag} = \frac{B^2}{2\mu}$ (limited by technology)



pressure balance : internal = external

$p_{B,inside} + p_{PL} = p_{B,outside}$

- How do you calculate differences in p_B
  - Simple for vacuum

define $\beta = \frac{p_{PL}}{p_B} = \frac{2nkT}{\left(\frac{B_0^2}{2\mu}\right)}$, B_0 taken right @ outer edge of torus

$\beta = 0$, $p_{PL} = 0$, No Good

$\beta = 1$, $B_{int} = 0$

$\beta < 0.2$ for Torus

$\beta \geq 0.9$ for Mirror

Matthew [illegible]

for ICF : $\beta = \frac{p_{PL}}{p_{Laser}} \approx 1$, Balancing plasma with momentum of light

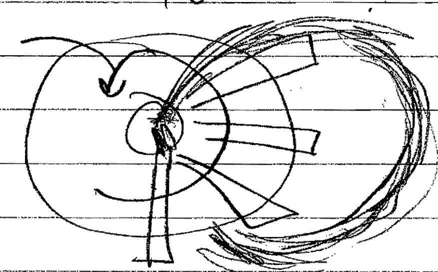
IEC : $\beta = \frac{p_{PL}}{p_E} \approx$, $p_E \overset{?}{\approx} \frac{E^2}{\epsilon}$

$p_{PL} \approx 100$ atm
$n = 10^{14}\ cm^{-3}$ $\approx$ 20 keV
$\sim 10^{19}$ @ atm.   0.625 eV
↳ Vacuum 10^{-5}

– Magnetic coil limiting

* Creating a Plasma
1. Pump down to 10^{-8}
2. Fill torus w/ DT to $10^{14}\ cm^{3}$
3. Heat Plasma
   - w/ current induced by transformer

j plasma



- j plasma creates B_Θ

- B-field becomes twisted within torus => tokamak