Theta pinch

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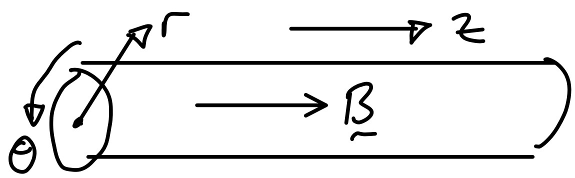
$$\underset{\sim}{J} \times \underset{\sim}{B} = \nabla P$$



$$\underset{\sim}{B} = B_z(r)\,\hat{\underset{\sim}{z}}$$

$$\frac{\partial}{\partial \theta} \to 0 \qquad \frac{\partial}{\partial z} \to 0$$

$$\underset{\sim}{J} = \frac{1}{\mu_0} \nabla \times \underset{\sim}{B}$$

$$= \frac{1}{\mu_0}\left[\frac{1}{r}\cancel{\frac{\partial B_z}{\partial \theta}} - \cancel{\frac{\partial B_\theta}{\partial z}}\right]\hat{\underset{\sim}{r}}$$

$$+ \frac{1}{\mu_0}\left[\cancel{\frac{\partial B_r}{\partial z}} - \frac{\partial B_z}{\partial r}\right]\hat{\underset{\sim}{\theta}}$$

$$+ \frac{1}{\mu_0}\left[\frac{1}{r}\frac{\partial}{\partial r}\cancel{(r B_\theta)} - \frac{1}{r}\cancel{\frac{\partial B_r}{\partial \theta}}\right]\hat{\underset{\sim}{z}}$$

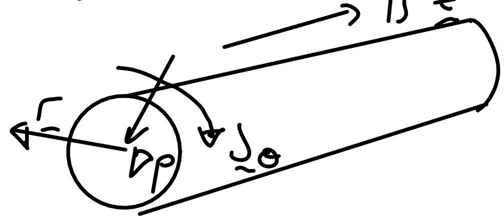
$$= \frac{-1}{\mu_0}\frac{\partial B_z}{\partial r}\hat{\underset{\sim}{\theta}}$$

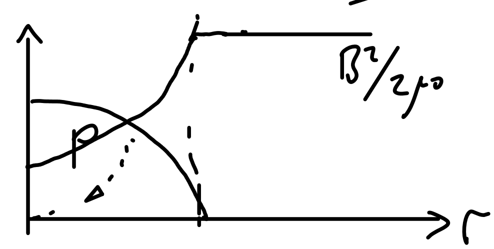
$$\underset{\sim}{J} \times \underset{\sim}{B} = \frac{-1}{\mu_0}\frac{\partial B_z}{\partial r}\hat{\theta} \times B_z \hat{\underset{\sim}{z}} = -\frac{1}{\mu_0}\frac{\partial}{\partial r}\left(\frac{B_z^2}{2}\right)\hat{\underset{\sim}{r}}$$

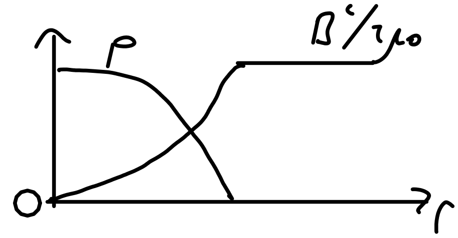
$$\hat{\underline{\theta}} \times \hat{\underset{\sim}{z}} = \hat{\underset{\sim}{r}}$$

$$= \nabla p = \frac{\partial p}{\partial r}\hat{\underset{\sim}{r}}$$

$$\frac{\partial}{\partial r}\left(p + \frac{B_z^2}{2\mu_0}\right) = 0$$



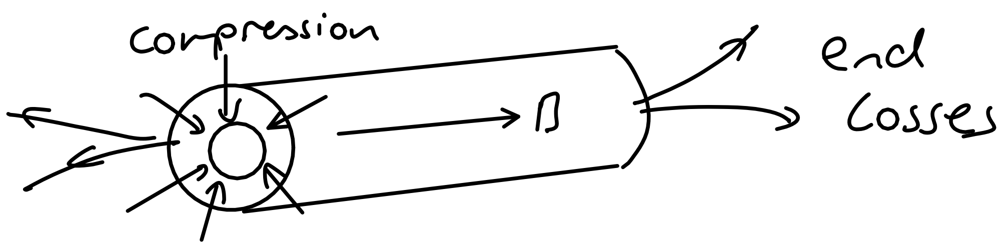


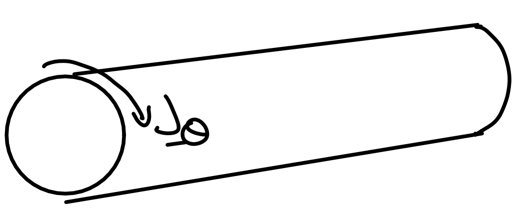


Maximum p is $\dfrac{B_{ext}^2}{2\mu_0}$

plasma $\beta = \dfrac{\text{fluid pressure}}{\text{magnetic pressure}}$

$$\text{Max } \beta = \frac{p}{B^2/2\mu_0} < 1$$





Diamagnetic current

- reduces extend field