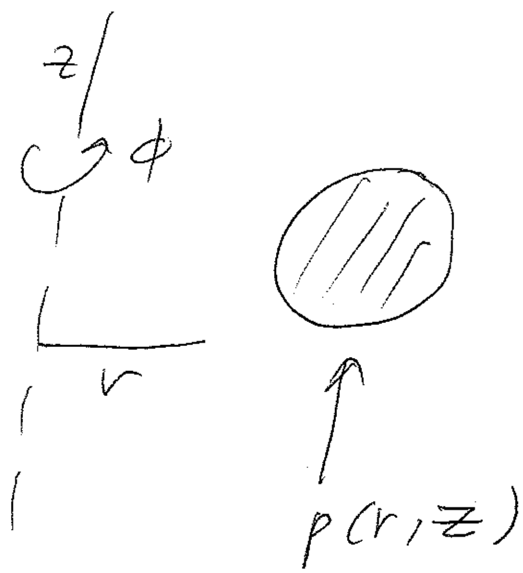
Soln to P8



$$\vec{\nabla}\left(p+\frac{B^2}{2}\right) = \vec{B}\cdot\vec{\nabla}\vec{B}$$

let $\vec{B} = \hat{\phi} B_\phi = \hat{\phi} B$

$$\Rightarrow \vec{B}\cdot\vec{\nabla}\vec{B} \rightarrow -\frac{B^2}{r}\hat{r}$$

$$\Rightarrow \boxed{\vec{\nabla}\left(p + B^2/2\right) = -\hat{r} B^2/r}$$

$p(r,z)$
$B(r,z)$

$\hat{z}$ component $\Rightarrow \frac{\partial}{\partial z}\left(p + B^2/2\right) = 0$

$$\Rightarrow \left(p + B^2/2\right) = f(r) \quad \text{—— } (1)$$

$\hat{r}$ component $\frac{\partial}{\partial r}\left(p + B^2/2\right) = -B^2/r$

$$\Rightarrow df/dr = -B^2/r$$

$$\Rightarrow B = B(r)$$

$\Rightarrow p = p(r)$ from (1)

$\Rightarrow p \neq p(r,z)$; leads to contradiction

$$nM\frac{d\vec{u}}{dt} = -\vec{\nabla}(p + B^2/2) + \vec{B}\cdot\vec{\nabla}\vec{B}$$

imagine $p \ll B^2$

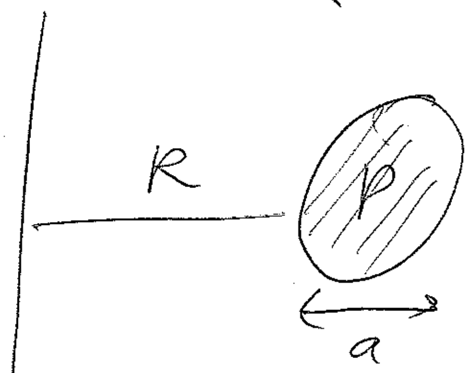
then $\nabla B^2 + B\cdot\nabla B$ ~~must~~ can balance

pretty much. $p(r,t)$ is what knocks things out of balance.

$$\Rightarrow \text{RHS} \sim O\left(\frac{p}{R}\right)$$

$$\text{LHS} \sim nM\frac{u}{\tau} \sim n\frac{Ma}{\tau^2}$$

$u \sim a/\tau$, time to move by "a"



$$\Rightarrow nM\frac{a}{\tau^2} \sim p/R \sim \frac{nT}{R}$$

$$\Rightarrow \frac{1}{\tau^2} \sim \frac{c_s^2}{aR}$$

$$c_s^2 \equiv T/M$$

$$\Rightarrow \boxed{\tau \sim \sqrt{aR}/c_s}$$

its "R", since if $R \to \infty$, RHS $\to 0$, ie, no imbalance in uniform field