Latter & Papaloizou 2017, local Boussinesq shearing box.
Also used by Lehmann & Lin 2023.

$$\nabla \cdot \underline{v} = 0$$

Total velocity in shearing box

$$\frac{\partial \underline{v}}{\partial t} + \underline{v} \cdot \nabla \underline{v} = -\frac{1}{\rho} \nabla P - 2\Omega \hat{\underline{z}} \times \underline{v} + 3\Omega^2 x \hat{\underline{x}} - 2\Omega^2 q_z z \hat{\underline{x}} - \left(H_R N_R^2 + H_z N_z^2\right) \frac{\delta \rho}{\rho}$$

typo in paper

$$\left(\frac{\partial}{\partial t} + \underline{v} \cdot \nabla\right) \frac{\delta \rho}{\rho} = \frac{\delta v_x}{H_R} + \frac{\delta v_z}{H_z} + C$$

Cooling

Turn off?

Add MHD + Hall

Should refer to Latter and Kunz 2022

$$\frac{\partial \underline{B}}{\partial t} = \underline{B} \cdot \nabla \underline{v}' - \underline{v}' \cdot \nabla \underline{B} - \frac{3}{2} \Omega B_x \hat{\underline{y}} - \eta_H \nabla \times \left[(\nabla \times \underline{B}) \times \hat{\underline{B}} \right]$$

Do we still need resistivity?

$$\underline{v}' = \underline{v} + \frac{3}{2} \Omega x \hat{\underline{y}}$$

(Velocity relative to Keplerian shear)

In mom. eqn

$$P \to P + \frac{|B|^2}{2\mu_0} \equiv \Pi$$

add magnetic tension $+ \frac{1}{\mu_0 \rho} \underline{B} \cdot \nabla \underline{B}$

Work with velocity relative to equilibrium? Note that equilibrium velocity has vertical shear.

Constrains equilibrium B field configuration.

vshear would generate B_y..

must have B_x in eqm if there is vshear...

Ignore vertical shear for now

$$\nabla \cdot \underline{V} = 0$$

$\underline{V}$ is relative to Kep.
(also eqm)

$$\frac{\partial \underline{V}}{\partial t} + \underline{V} \cdot \nabla \underline{V} = 2 V_y \Omega \hat{\underline{x}} - \frac{\Omega}{2} V_x \hat{\underline{y}} - \frac{1}{\rho} \nabla \Pi$$

$$- N_R^2 \Theta \hat{\underline{x}} + \frac{1}{\mu_0 \rho} \underline{B} \cdot \nabla \underline{B}$$

$$\left(\frac{\partial}{\partial t} + \underline{V} \cdot \nabla \right) \Theta = \delta V_x + C$$

ignore?

$$\Theta = H_R \frac{\delta \rho}{\rho}$$

$$\frac{\partial \underline{B}}{\partial t} = \underline{B} \cdot \nabla \underline{V} - \underline{V} \cdot \nabla \underline{B} - \frac{3}{2} \Omega B_x \hat{\underline{y}}$$

$$- \eta_H \nabla \times \left[(\nabla \times \underline{B}) \times \hat{\underline{B}} \right]$$

+ resistivity ?