Plasma Physics and Magnetohydrodynamics Class Notes (April 8th, 2019)

Dimensionless Numbers:

1. Plasma $\beta = \frac{8\pi P}{B^2}$ $\beta \gg 1$: Plasma dominates magnetic field (Dynamos)
   $\beta \ll 1$: Magnetic field dominates Plasma (fff)

2. Reynolds Number: $R = \frac{Lv}{\nu} = \frac{inertial\ force}{viscous\ force}$
   $R \gg 1$: Inertial force dominates (Turbulence)
   $R \ll 1$: Viscous force dominates (Static) (Peanut Butter, Honey)

3. Magnetic Reynolds number: : $R_m = \frac{Lv}{\eta}$
   $R_m \gg 1$: ideal MHD, frozen-in flux
   $R_m \ll 1$: Diffusion dominates

4. Lundquist Number: $S = \frac{Lv_A}{\eta}$ $S \geq R_m$
   (the same physical reasoning with magnetic R_m)

5. Mach Number: $M = \frac{v}{c_s}$
   $M \gg 1$: shocks
   $R_m \ll 1$: flow

6. Magnetic Mach number: : $M_m = \frac{v}{v_A}$
   (similar physical reasoning)

7. Prandtl number: $P_r = \frac{\nu}{\kappa} = \frac{momentum}{themal\ conductivity}$
   $P_r \gg 1$: Plasma loses its energy; static plasma
   $P_r \ll 1$: Isothermal plasma

8. Lorrentz Factor: $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$ (almost never relativistic, therefore is ignored set to 1)

9. Rossby Number: $R_0 = \frac{\nu L}{\Omega} = \frac{internal}{coriolis}$
   $R_0 \gg 1$: ignore Coriolis force (Bath Tub)
   $R_0 \ll 1$: Coriolis force is important