29:293 Homework #8

Due at the beginning of class, Thursday, April 16, 2015.

1. Hydrodynamic Turbulence

If a cup of coffee has a radius of about 5 cm, and it takes 2 seconds to stir around the cup once, estimate the time it takes for the turbulence to reach the viscous scale of approximately 10^{-2} cm.

2. MHD Turbulence in the Solar Wind

Although the solar wind is actually a collisionless plasma, it has been rigorously shown that the dynamics of Alfvén wave turbulence is well described by MHD at scales larger than the ion Larmor radius r_{Li} . If the turbulence in the solar wind is driven isotropically ($L = L_{\perp} = L_{\parallel}$) at a scale of 10^{12} cm with a velocity equal to the local Alfvén velocity, estimate the anisotropy (k_{\parallel}/k_{\perp}) of critically balanced fluctuations when the perpendicular scale of the ion Larmor radius has reached, $k_{\perp}r_{Li} = 1$. The parameters of the solar wind plasma are $B_0 \sim 10^{-4}$ G, $T_i = T_e \sim 5 \times 10^4$ K, and $n_i = n_e \sim 20$ cm⁻³. (In this calculation, do keep factors of 2π).