# 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 $10^{-2} \mathrm{~cm}$.
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 $r_{L i}$. If the turbulence in the solar wind is driven isotropically $\left(L=L_{\perp}=L_{\|}\right)$at a scale of $10^{12} \mathrm{~cm}$ with a velocity equal to the local Alfvén velocity, estimate the anisotropy $\left(k_{\|} / k_{\perp}\right)$ of critically balanced fluctuations when the perpendicular scale of the ion Larmor radius has reached, $k_{\perp} r_{L i}=1$. The parameters of the solar wind plasma are $B_{0} \sim 10^{-4} \mathrm{G}$, $T_{i}=T_{e} \sim 5 \times 10^{4} \mathrm{~K}$, and $n_{i}=n_{e} \sim 20 \mathrm{~cm}^{-3}$. (In this calculation, do keep factors of $2 \pi$ ).

