Problem set 8. Due Thur Apr 7.

April 7, 2011

- Derive dispersion relations for Alfvén waves in the case when there is resistivity $\eta \neq 0$.

  Assume $\delta B, v \propto y$.

$$
\begin{aligned}
&-\omega v = B_0 B_1 k_z/(4\pi) \\
&-i\omega B_1 = iB_0 k_z v - k^2 \eta B_1 \\
&\omega = -(i/2)k^2\eta \pm (v_A^2 k_z^2 - k^4\eta^2/4)^{1/2}
\end{aligned} \tag{1}
$$

  Imaginary ω or k? Does not matter, depends on a set up. Transform to frame moving with the wave, $\omega = 0$, only k remains, k is real, waves decay, ω is complex. Look how a wave emitted from a point decays in time. ω is real k complex. If damping it large overdamped oscillator.

- In the frame of the MHD shock the magnetic field in the upstream medium is inclined at an angle θ to the shock normal. Velocity of the shock with respect to the upstream medium is V. For a given magnetic field line, find the velocity of the imaginary point of its intersection with the shock (in the frame of the shock). When does this velocity becomes larger than the speed of light?

$$v = v_s/\cos\alpha = c \tag{2}$$

- Surface current in a MHD shock. Consider a normal shock (so that magnetic field is in the plane of the shock and velocity is normal to the shock surface). Let in a pre-shock medium magnetic field be B_0. Assume that the shock is strong, so that compression ratio is 4. Calculate the surface current on the shock.

$$\Delta B = 3B_0 = (4\pi/c)g \tag{3}$$