

CSI 769 Fall 2010
Solar and Heliospheric Physics

Homework Assignment 7

Assignment Date: Nov. 14, 2010

Due Date: Nov. 18, 2010

1. MDH Waves

Draw the Friedrichs diagram of MHD wave to scale in the Sun's corona using the following parameters. The magnetic field is 1000 Gauss, temperature is 1 MK, and electron density is $10^9 / \text{cm}^3$.

- (1) What is the speed of Alfvén wave?
- (2) What is the speed of sound wave?
- (3) What is the speed of the fastest MHD wave? What is its mode?
- (4) What are the speed of slow mode, intermediate mode and fast mode waves when the propagation direction of the wave is 45° from the direction of magnetic field?
- (5) Draw the Friedrichs diagram using true numbers?

Note: (1) For the drawing, you need to use computer program to plot out the diagram, either in IDL or Matlab, or any other programs you prefer.

(2) The fast/slow mode MHD wave equation is found (from MHD equations using perturbation method) to be

$$\frac{\omega^2}{k^2} = \frac{V_A^2 + C_s^2}{2} \pm \frac{1}{2} \sqrt{(V_A^2 - C_s^2)^2 + 4C_s^2 V_A^2 \sin^2 \theta}$$

(3) For a fully ionized plasma such as corona, thermal pressure $P=2n_e kT$

(4) For a fully ionized plasma such as corona, mass density $\rho = n_e m_p$