Wave Stuff

acoustic waves

- Longitudinal
- propagate by means of adiabatic compression and decompression
- travel at sound speed (determined by medium)
- Important quantities:
  - sound pressure
  - particle velocity
  - particle displacement
  - sound intensity
- exist because of a pressure restoring force: local compression (or rarefaction) sets up a *pressure gradient* in opposition to the motion
- carry energy away from source
- large enough amplitude → shock wave, but usually small; ambient gas slightly disturbed
- exist in medium with low or non-existent magnetic field
- isotropic

Alfvén waves Incompressible,

body modes

dispersion relations Equations that describe

fast waves

$$C_{A_0} < C_{fast} < C_{A_e}$$

Fast modes are highly dispersive.

gravity waves

kink modes/waves/oscillations (from wikipedia:) Kink (or transverse) modes, are oblique (inclined with respect to the flow direction) fast magnetoacoustic (also known as magnetosonic waves) guided by the plasma structure; the mode *causes the displacement of the axis of the plasma structure*. These modes are *weakly compressible*, but could nevertheless be observed with imaging instruments as *periodic standing* or *propagating* displacements of coronal structures, e.g. coronal loops. The frequency of transverse or "kink" modes is given by the following expression:

$$w_K = \sqrt{\frac{2k_z B^2}{\mu(\rho_i + \rho_e)}}$$

In a cylindrical model of a loop, the parameter *azimuthal wave number*, m, is equal to 1 for kink modes. This means that the cylinder is "swaying with fixed ends"...?

In the long wavelength limit, the phase speed of all but sausage fast modes tends to the so-called kink speed, which corresponds to the density weighed average Alfvén speed.

leaky modes Waves are allowed to radiate into the external medium, i.e. the condition of mode localization is relaxed. Bessel functions are replaced by Hankel functions in the dispersion relation.

longitudinal waves waves in which the displacement of the *medium* is in the same direction as, or the opposite direction to, the direction of travel of the wave.

magnetoacoustic waves A magnetosonic wave (also magnetoacoustic wave) is a longitudinal wave of ions (and electrons) in a magnetized plasma propagating perpendicular to the stationary magnetic field.

modes A wave may be a superposition of lots of other waves. Each of those waves is a "mode" of the resultant wave (think of the foundation of Fourier Analysis: sums of sines and cosines). Modes with the lowest wave number are *global*, or *fundamental* modes.

oscillations Three types:

1. un-damped
2. damped
3. forced

pressure waves This is what pressure waves are ...

sausage modes The sausage mode approaches a cut-off at the external Alfvén speed. Trapped sausage modes do not exist at longer wavelengths.

speeds Characteristic speeds of MHD are the sound speed and Alfvénic speed, given by: $C_s = \sqrt{\frac{\gamma p_0}{\rho_0}}$ and $C_A = \frac{B_0}{\sqrt{\mu_0 \rho_0}}$

slow waves

surface modes evanescent behavior in both media (inside and outside cylindar).

$$C_{T_0} < C_{slow} < C_{s_0}$$

transverse waves (from wikipedia:) moving waves that *consist* of oscillations occurring perpendicular to the direction of energy transfer. If a *transverse* wave is moving in the positive x-direction, its *oscillations* are in up and down directions that lie in the yz plane. Light is an example of a transverse wave. ($\vec{B}$ and $\vec{E}$ oscillate in directions perpendicular to the direction in which the light is actually traveling). With regard to transverse waves in matter, the *displacement of the medium* is perpendicular to the direction of propagation of the wave. Examples: A ripple in a pond and a wave on a string.

waves Caused by any turbulence in a medium.

wave number Number of waves in a unit distance. $k = 2\pi$