27. Fast wave, fast shock, perpendicular shock, entropy, jump relation.

Consider the fast perpendicular shock.

(a) Determine the positive root of the solution for the compression ratio. How does the compression ratio behave for very large (10) and very small (0.1) upstream plasma β?

(b) Derive the downstream Mach number as a function of upstream Mach number and for small and large plasma β. How does the downstream Mach number change as a function of β for fixed upstream Mach number?

(c) An important quantity for space plasma processes is entropy. A measure of entropy is $s = p/n^{\gamma}$. Determine the downstream to upstream ratio of s as a function of upstream Mach number and plasma β. Plot this ratio and the compression ratio as a function of plasma β for a fixed upstream Mach number of 20. What is the value of the minimum upstream plasma β to sustain a shock? Why?

28. Simulation of a hydrodynamic shock.

The initial condition 8 in the simulation code is an example for a hydrodynamic shock. Note, in order to run this stable and without large oscillation you may need to increase a viscosity parameters significantly.

(a) For what choice (visrho, visv, visu) and what values of the viscosity do you get a reasonably stable solution?

(b) Run the code for two different upstream Machnumbers and use methods 0, 1, and 2 for the treatment of the energy equation (parameter intu; values 0 and 1 correspond to different treatments of entropy conservation and 2 corresponds to energy conservation). Describe any differences in the results. Compare the analytic jump conditions for a hydrodynamic shock with your results for the two Machnumbers. Discuss these results. (Note, that for larger Machnumbers you may need higher viscosity and/or possibly also a wider transition region parameterized with l_0 in the program).

29. Project

Continue work on your project and provide a brief progress report.

Please turn in the solutions to the homework on Friday, 4/11/2014