

Problem Set 9

Problems to Theoretical Astrophysics, SS 2014

Prof. Dr. Friedrich Röpke, Sebastian Ohlmann

Offices: Campus Hubland Nord, 31.01.017, 31.01.003

Tutorial on Friday, 11.07.2014, 12.30 pm

1. Mathematical structure of the Euler equations

The one-dimensional Euler equations without external forces can be written in a *quasi-linear form* as

$$0 = \frac{\partial \mathbf{Q}}{\partial t} + \frac{\partial F(\mathbf{Q})}{\partial x} = \frac{\partial \mathbf{Q}}{\partial t} + \frac{\partial F}{\partial \mathbf{Q}} \frac{\partial \mathbf{Q}}{\partial x}.$$

- Give expressions for the vector of conserved quantities \mathbf{Q} and for the flux vector $F(\mathbf{Q})$.
- Compute the *Jacobian matrix* $(\partial F)/(\partial \mathbf{Q})$ assuming an ideal equation of state $P = (\gamma - 1)\varepsilon_i$, where ε_i is the internal energy density.
- Compute the Eigenvalues of this matrix and interpret the results.