1 General Considerations

$$\frac{D\rho}{Dt} = \frac{\partial\rho}{\partial t} + u_i \frac{\partial\rho}{\partial x_i} \neq 0 \qquad (1)$$

- Wave propagation
- Convective flows with buoancy
- Flows with variable temperature, friction, sources of heat
- High speed flows with Mach numbers $Ma \geq 1$

Compressible flows can still be described through the continuum model and conservation laws. The assumption is also that the thermodynamic state of the fluid is in a local equilibrium.

Assumptions

- Length scale of flows large compared to molecular scales (mean free path λ)
- Length scale of flows small compared to the geometric scales (length L)
- Time scale τ_F of the flow long compared to the molecular process (relaxation) time constants τ_R

Description of the "Continuum" Flow State

- Three components of flow velocity $\underline{u}(\underline{x}, t)$
- The fluid density $\rho(\underline{x}, t)$
- The fluid pressure $p(\underline{x}, t)$
- The energy $e(\underline{x}, t)$

2 Thermodynamic Relations

2.1 State Variables

3 Conservation Laws for Continuum Flows

4 Simplification Strategies

5 Conservation Laws for Stream Tubes

6 Steady one-dimensional Flow without Friction and Heat

7 Unsteady one-dimensional Flows

8 Two-dimensional steady supersonic Flow

9 Method Characteristics for planar homentropic supersonic Flows

10 Homentropic Flow around slender Wings

11 Homentropic Flow around axisymmetric slender Bodies

12 Similarity Relations