

1 General equations - first year overview

This is made in May 2019.

1.0.1 Hydrodynamics

Euler equations, together with closing relation (e.g. ideal gas law).

primitive variables			
mass density	velocity	gas energy density	gas pressure
ρ	v	e	p

1.0.2 Radiation

Radiative transfer equation: intensity along a ray while interacting with medium. Photons are massless.

$$\left[\frac{1}{c} \partial_t + \vec{n} \cdot \vec{\nabla} \right] I_\nu = \eta_\nu - \chi_\nu I_\nu \quad (1)$$

frequency	intensity	emissivity	total absorption
ν	I_ν	η_ν	χ_ν

These deliver two equations

- the radiative energy equation (diffusion flux \vec{F})

$$\frac{\partial E}{\partial t} + \vec{\nabla} \cdot \vec{F} = \iint \dots d\nu d\Omega \quad (2)$$

- radiative momentum equation

$$\frac{d\vec{F}}{dt} = \iint \dots \vec{n} d\nu d\Omega \quad (3)$$

(after **integrating over all frequencies**). Depending on the geometry simplifications, one can e.g. integrate over all solid angles.

1.0.3 Radiation-Hydrodynamics

Combination delivers integral-diffusion equation

$$\begin{aligned} \frac{dI}{d\tau} &= S - I \\ &= \int I d\Omega - I \end{aligned} \quad (4)$$

1.0.4 Challenges

- combination with hydrodynamics
- current analysis: simplified geometries (symmetry). E.g. in 2D, an ADI method is used and now also a multigrid method.
- complex geometry difficult to show in ray-tracing scheme
- steady-state vs. time dependent
- focus on radiation equations