

(25.9.18) Computational Physics B

class 1

- RT instability (linear)
 - linear growth rate γ_{RT} depends on the wave number, which is similar to the $\omega(k)$ relation.
 - $Q = Q_0 + \delta Q$, where $\delta Q = e^{i(kx-\omega t)}$ is in plane wave form.
 - fastest growth are in the shortest wavelength.
- RT instability (non-linear)
 - saturation vs runaway
 - Why saturation? --> $\gamma_{grow} \sim \gamma_{damp}$
 - Q1. But where does damping come from? And why does this increase intensity when chaos stronger?
 - turbulent damping --> turbulence power spectrum, when the scale becomes small, the energy damped to thermal energies.
 - something different: magnetic field tension, 2D wave
 - non-linear stage is the crucial stage which we focus on.
 - example for RT instability
 - supernova surroundings with finger-like structure
- How to quantify instability in numerical simulation?
 - amplitude of the bubble $h(t)$
 - the strength of turbulence --> mean field theory, deviation of the turbulence velocity δu_{turb}
 - only looks at some direction of the velocity field, can ??
 - $v = \nabla\phi + \nabla \times \vec{A}$, the first term is the compressible part, the second term is the solenoidal part.
 - for example, if the compressible part is large, the star formation is easier.
 - power spectrum
 - use the characteristic strength of the turbulence power spectrum to quantify the instability.

class 2

- How to convert continuous fluid into simulations?
 - discretization for spatial and temporal domain.
 - grid-based method

- finite volume method (FVM)
 - uniform grid vs non-uniform grid
 - static mesh refinement vs adaptive mesh refinement(the refinement will change with the motion of our object)
- Eulerian --> the change rate of some fluid quantity at a fixed point in space. $(\frac{\partial \phi}{\partial t})_{\vec{x}}$
 - the fluid dynamic equations only suit for fluid themselves, when there exists source or sink terms, we may need to consider other physical processes.
- discretization by mass
 - particle-based method
 - Lagrangian --> the change rate of some fluid quantity moving with the fluid. $\frac{d\phi}{dt} = (\frac{\partial \phi}{\partial t})_{\vec{x}} + \vec{v} \cdot \nabla \phi$
 - a particle moving with the fluid --> total derivative $\frac{d}{dt} = \frac{\partial}{\partial t} + \vec{v} \cdot \nabla$, the second term is the advection term.
 - the fluid dynamic equations become ODEs, and is easier to solve.
 - smoothed particle hydrodynamics (SPH) --> Gizmo