Reynolds number

Contents

- Viscous fluid equations
- Reynolds number
- Viscosity and numerical methods

$$\frac{\partial \underset{\sim}{u}}{\partial t} + \underline{u} \cdot \nabla \underline{u} = -\frac{1}{\rho} \nabla P + \frac{\mu}{\rho} \nabla^2 \underline{u} + \frac{1}{3} \frac{\mu}{\rho} \nabla (\nabla \cdot \underline{u})$$

viscosity

Approximate magnitude $\nabla \sim \frac{1}{L}$ L = typical length scale

$\underset{\sim}{v} \sim u$

$$\underset{\sim}{u} \cdot \nabla \underset{\sim}{u} \sim \frac{u^2}{L}$$

$$\frac{\mu}{\rho} \nabla^2 \underset{\sim}{u} \sim \frac{\mu}{\rho} \frac{1}{L^2} u$$

$$= \frac{\nu u}{L^2}$$

$\frac{\mu}{\rho} = \nu$ kinematic viscosity

Reynolds number $Re = \frac{u^2 / L}{\nu u / L^2} = \frac{L u}{\nu}$

Re large $\rightarrow$ large number of mesh points

$Re \gg 1$ Viscosity not important

$Re \sim 1$ Viscosity balances advection

Need a smooth solution on mesh (Taylor)

$\Rightarrow$ need diffusion to ensure

$Re \sim 1$ on mesh $L \sim \Delta x$

$$\frac{\Delta x\, U}{\nu} \sim 1 \qquad \underline{\Delta x \sim \frac{\nu}{U}}$$